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Journal

—OF THE—

American Ceramic Society

A Monthly Journal devoted to the Arts and Sciences Related to the Silicate Industries

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Vol. 3 **August, 1920** **No. 8**

EDITORIAL

WORKING ON A SALARY

The trouble about working on a salary is that you do not discover it is not the road to success until it is too late to change.

It is a rather remarkable circumstance that very few of the graduates from the ceramic schools of this country have engaged in business for themselves. In part, this is due to the fact that the bulk of these men are still recent graduates. However, there are quite a number of graduates of ten and fifteen years standing, and a few that have been out of college for twenty years. The trouble seems to be that while in college they were trained to think of success in terms of salaries. College professors, being themselves salaried men, are naturally inclined to measure success in that way. You may send a boy to school for technical training, but while there he will absorb from his instructors many other things, including ideas and ideals in regard to life. In many respects this is very desirable, and in others it is quite unfortunate.

The young man leaving college naturally starts to work on a salary. On receiving his first or second raise he marries and begins the serious business of establishing a home and founding a family. As the years go on his salary increases and his expenses also. Since he is always able to meet expenses and in addition to keep up some life insurance and probably to make

small but regular payments on a home, he is usually very well satisfied with the course of events for some ten or fifteen years. Along about the time he reaches the age of forty he is apt to realize rather suddenly that he is not getting ahead as fast as men of his own age who started in business for themselves in a small way when young. He sees many of these men on the road to making fortunes and regretfully is forced to the conclusion that he will never be able to do so while working on a salary.

For a man in middle life nothing is easier than to continue to work at a good salary. It takes considerable courage and often the exercise of a large amount of self-denial, on the part of himself and his family, for him to give up his comfortable salaried position and to start into business for himself. In general, it would be necessary for him to start in a very small way, for during the years he has been working on a salary, although his income may have been as large, or larger, than that of the man in business for himself, yet as a salaried man he has not had the same incentive to save, and therefore has accumulated little capital. Usually, with a sigh of regret for what might have been, he reconciles himself to the prospect of being a salaried man the rest of his life and pretends he likes it. The difference between the successful business man and the middle-aged man on a salary is not a difference in native ability and seldom a difference in opportunity. Generally it lies in the fact that the one had a fixed determination to get into business for himself and acted on that determination while he was a young man and in a position to take a chance.

We are not saying that the technical man of ability that enables him to hold a position at a good salary, year in and year out, has not attained a measure of success. We are not saying that he is not a desirable and useful citizen. We do hold, however, that in most cases he has not attained the full development of personality and character that would have been possible if he had gone into business for himself. In general, he is fundamentally not as happy and contented, for the desire to possess an independent business is one of the primary instincts of men. The difference in wealth is incidental only. The truly successful business man takes pride in his possessions only in that they

are an evidence that he has played his part in a big and dangerous game, and played it well.

We believe that it will be to the advantage of the ceramic industries of this county, even from the technical side, if the young men with technical training are urged to aim high, to set as their goal not the attainment of a position paying a high salary but the possession of a business of their own. If this is done a fair proportion of these men will reach this goal and will then be in a position to put into practical operation many of the reforms in technical procedure that even now remain idle dreams, simply because the men who realize the necessity for these reforms are not in a position to execute them. At present most of the technical knowledge is in possession of one set of men, and most of the executive power and capital is in the possession of another group. This condition does not tend to bring about rapid progress along technical lines in the ceramic industries of the country.

ORIGINAL PAPERS AND DISCUSSIONS

ULTRAMISCROSCOPIC EXAMINATION OF SOME CLAYS[1]

By Jerome Alexander

Prior to the World War, the United States had been largely dependent upon Germany and Austria for its supply of optical glass and many of the scientific and optical instruments which comprise optical glass in their construction; so that when this country was forced into the struggle, it was imperative that we should discover and put into practical operation on a large scale methods for producing about a dozen essential varieties of optical glass. How this work was speedily and successfully accomplished has been told by Dr. Arthur L. Day, of the Geophysical Laboratory (Carnegie Institution of Washington), who was in charge of the Section of Optical Glass Production, War Industries Board.

One of the subsidiary problems involved was the manufature of suitable glass-pots; and in this connection it became necesary to substitute American clays for German clay which had been in use before the war. This led Dr. Day to raise the question whether a more fundamental definition of properties could not be found; and on November 24, 1917, there were sent the writer (who was then Chairman of the Sub-committee on Glue and other Colloids, Division of Chemistry, National Research Council), eleven samples of clay, which were subjected to ultramicroscopic examination with a view of finding out whether any material differences would be discernible, and if so, whether the differences would bear any relation to the working properties of the clays.

[1] Received February 27, 1920.

A small quantity of clay was mixed with about two hundred times its weight of water, and a drop of the well stirred mixture made into a slide and examined with the aid of a Leitz dark-field, using a $^1/_{12}$ oil immersion objective. This examination was preliminary and qualitative; but, as may be seen from the accompanying table, it showed very marked differences between the several clays, and indicated the basis of some of the physical differences in clays.

In April, 1918, further examination was made of the same clays which had been washed or lixiviated with water and then allowed to settle for nine minutes, the second samples representing what had then been poured off with the supernatant fluid. The results of this second examination are given following the table. The examinations were made in total ignorance of information regarding the working properties and uses of the clays; and it is therefore interesting to note how this information, received about a year later, harmonizes with the results.

Both examinations were repeated in the presence of Dr. Day and the results discussed with him; but following the armistice, work on optical glass problems ceased abruptly. Just recently Mr. A. V. Bleininger of the Bureau of Standards, who had supplied the samples, has kindly given me a description of the clays and their working properties; and these facts coupled with the ultramicroscopic results may be of value to those interested in clays and their uses.

The properties of clays are, of course, greatly influenced by their chemical constitution (which changes with the presence of incidental minerals); but entirely apart from this, the degree of subdivision or aggregation of the clay particles has an important influence on the clay and its uses. Water is the chief agency responsible for the weathering of the clay-forming minerals and rocks, and for the subsequent leaching, disintegration, mechanical pulverization and segregation of the resulting clay particles, whose subsequent condition is largely controlled by two colloid-chemical factors: (1) The presence of deflocculating substances, such as alkalis and organic extractives (humus, etc.); (2) the presence of coagulating or flocculating substances, such as chlor-

ides, sulphates, iron salts, acids resulting from oxidation, hydrolysis, differential diffusion, etc.

Apparently deflocculating substances are adsorbed at the surfaces of the clay particles, resulting in their greater hydration. Such surfaces not only tend to hold more water, but are more easily wet, and more readily separated; the water or moisture films, or films of moist deflocculator, prevent the particles from approaching within the most powerful range of molecular attraction. Baking removes or destroys these protecting films, and consolidates the particles; the degree of their union depending upon time and temperature of heating. In like manner gelatine superdried at about 150 degrees C becomes insoluble, apparently reverting to ossein.[1]

Coagulating substances, heat and pressure have an aggregating and dehydrating tendency. They tend to reduce the total free or active surface of the clay. But in most clays there is a balance between flocculating and deflocculating factors, and their interplay controls the ratio between pore water and shrinkage water, and is largely reponsible for the physical properties of the clay.

In fact each clay as it occurs in nature bears within itself much evidence of its geological history, the chemical and mechanical disintegration processes of past ages; lixiviation by glacial or other waters; subsequent sedimentation in still lakes or flats, or coagulation by saline waters; leaching out of some salts or soluble products; infiltration of other salts and of organic extractives; pressure of overlying strata; thermal changes due to solar heat, volcanic action, or metamorphic movements of the earth's crust which also cause pressure. All these factors which have acted on clays as we find them, and offer a wide field for careful scientific study, so that we may learn how to test, treat and mix clays to produce the practical results desired; for once we understand the principles governing the properties of clays, we can work upon them with substances much more powerful than those found in nature.

Many clays undergo washing or other treatment at the mines

[1] See Allen's commercial organic analysis, 4th ed. **8**, 586.

or pits, and may differ materially from the clay as mined. This must, of course, be taken into consideration in forming opinions regarding the commercial product.

With reference to the table, some explanation of the terms and abbreviations used is essential.

Large particles are those approximating in actual diameter about 0.025 mm.

Small particles are those approximating in actual diameter about 0.005 mm.

Colloidal particles are those below the limit of microscopic resolvability. Their relative size was estimated on the basis of the brightness of their diffraction images and the nature of their motion.

The appearance referred to as *reticulated*, indicates that the larger particles so described were formed of smaller individuals united by coagulation, dehydration, heat, or pressure, or some combination of these.

The expression *gel groups* or *gel particles*, means the occurrence of somewhat more loosely bound groups of particles, similar in appearance to, though larger than, the groups of ultramicrons observable in agar gel.

The term *hampered* in connection with the motion of the colloidal particles, means that they acted as though some crystalloid salt or other coagulant was present. In several of the samples this effect was so pronounced that a separate column was made headed "crystalloidisis," to bring out this point.

++ means marked crystalloidisis.

+++ means very marked crystalloidisis.

The expression *diplococci* indicates the presence of groups of two (or three) ultramicrons, an appearance characteristic of the incipient coagulation of colloids like casein, for example.

In the case of the clays there seems to be a balance between the flocculating and deflocculating forces, depending upon their nature, the amounts present, the dilution, the age of solution, and so forth.

No.	Description of Sample	Ultramicroscopic Examination: Particles: Large	Particles: Small	Particles: Colloidal	Colloidal motion	Crystalloidisis	Mixed with Equal Weight of Water: Order of acidity to litmus	Mixed with water	Feel	Appearance
1.	English kaolin	Few, reticulated	Few	Many	Very active		1	Easy	Smooth	Moist cream
2.	Georgia kaolin	More than (1)—not reticulated	Many	Fewer than (1)	Slow, comparatively		1	More difficult than (1)	Smooth	Moist cream
3.	Florida kaolin	Fewer than (2)—reticulated	Fewer than (2)	More like (1)	Active—not as active as (1)		2	Easy	Less smooth than (2)	Drier than (2)
4.	North Carolina kaolin	Many—some very large, some yellow with adsorbed Fe	Many Many	Many (large)	Slow		2	Easy	Rough	Drier than (3)
5.	Tennessee ball clay No. 5	Few	Many	Many	Very slow	++	3	Very easy	Smooth and sticky	Wet
6.	Kentucky ball clay No. 4	Many very large gel particles	Few	Small	Hampered	+++ diplococci	4	More difficult than (5)	Stickier than (5)	Drier than (5)
7.	Illinois Kaolin Co. plastic clay	Practically none	Many gel groups	Many	Hampered		3	More difficult than (1) or (5)	Very smooth and sticky	Dry
8.	Highland fire clay	Many—huge masses	Many	Large	Slow		3	Easy	Gritty	Wet—free water
9.	Laclede-Christy bond clay 69B	Practically none	Many	Small	Very active		5	Easy		Very wet—free water
10.	Plastic clay Camden, Ark.	Many—mostly sharp crystals	Many	Large	Slow	++	4	Easy	Harsh	Wet
11.	Delaware kaolin Newark Kaolin Co.	Some—mostly gel and reticulated	Few	Small	Hampered	++ diplococci	2	Easy	Smooth but harsh	Wet—free water

The following notes were made after second ultramicroscopic examination, the samples being the same as before, except that they had been "decanted after nine minutes."

Sample(*1*). English China Clay. Same as first report. Easily breaks up in water.

Sample (*2*). Georgia Kaolin. Particles much larger than (1). Show indistinct reticulation and appear in large masses. Practically no motion in the upper layers of the field. Small particles motionless at the bottom.

Sample (*3*). Florida Kaolin. Mostly large reticulated masses. Few small particles very active, but none as active as (1).

Sample (*4*). North Carolina Kaolin. Same as first report. Colloidal motion more active.

Sample (*5*). Tennessee Ball Clay No. 5. Same as first report. Colloidal motion more active.

Sample (*6*). Kentucky Ball Clay No. 4. Same as first report. Colloidal motion much more active. Subdivision greater than (5).

Sample (*7*). Illinois Kaolin (sample so marked). Motion hampered. Particles apparently large. Many large reticulated gel groups. Numerous diplococci.

Sample (*8*). Highland Fire Clay. Particles so large as to be mostly microscopic. Colloidal particles relatively few, slow in motion.

Sample (*9*). Missing. (Laclede-Christy Bond Clay 69B).

Sample (*10*). Arkansas Fire Clay (sample so marked). Many large crystal fragments. Colloidal particles comparatively few with slow and hampered movement. As a rough estimate about $^2/_3$ of the particles by weight are quite large, and $^1/_3$ quite small, the relative average apparent size of individuals in the two groups being about as 10 to 1.

Sample (*11*). Delaware Kaolin. Same as first report. Colloidal motion more active.

In several of the washed samples, the effect of the removal of some of the coagulative salts or coagulants is shown by the increased colloidal activity.

There will now be given *within brackets*, Mr. Bleininger's very comprehensive descriptions of the several clays, followed by some remarks on the ultramicroscopic evidence.

(1) *English Kaolin.* (This kaolin is of primary origin and comes from St. Austel, Cornwall, England. It is claimed by some geologists that this deposit has been formed from the granites and pegmatites through the action of volcanic gases containing appreciable amounts of fluorine. This kaolin in the crude state is freed from quartz and undecomposed feldspar, by a very elaborate washing process. As a result, this material corresponds quite closely to the theoretical composition, $Al_2O_32SiO_22H_2O$. With reference to fineness of grain it seems to have the proper combination of sizes so as to insure the maximum plasticity possible in primary kaolins. Its color is exceptionally white. In the nature of the case all primary clays, not having been transported and acted upon by water, are inherently coarser than all secondary clays which have undergone transportation. The mechanical strength of the dry primary clay is therefore inferior to that of secondary materials. The tensile strength of this clay in the dry state is about 30 pounds per square inch, the compressive strength about 200, and the transverse strength about 70 pounds per square inch. Although lower in truly colloidal clay substance, this clay is still fine enough to serve admirably as a filler for paper and seems to be the best material available for this purpose, especially for the high grades.)

The comparative freedom of this clay from larger size particles shows the care with which the washing and floating took place. The activity of the colloidal motion indicates the absence of coagulating substances, and perhaps the addition of deflocculating substances, or their presence in the local water. It would seem that the relative weakness of the dry clay is due to the uniformity of its particles, but largely also to their hydration, the intensity with which they hold fast to their absorbed water films.

(2) *Georgia Kaolin.* (This material differs geologically from the English kaolin in being of secondary origin, having been transported from its place of origin and consequently having undergone considerable grinding action. While the composition of this clay approaches the kaolinite formula quite closely, still it carries impurities, especially titanates of iron, which impart to the material a creamish color. The plasticity of this clay is

much more developed than with the primary kaolins but it would seem that there is not a sufficient gradation in the size of the particle to develop the best working quality. It must be understood that mere fineness is not the most desirable condition in clay. We must have also a certain gradation of sizes to have the best working qualities. Clays of this type are inclined to be sticky, that is, show excessive plasticity if we may use this term. For this reason also this clay is somewhat inclined to crack during drying, probably due to an excess of colloidal substance. The tensile strength of Georgia kaolin is about 100 pounds per square inch, the compressive strength about 450, and the transverse strength about 250 pounds per square inch.)

This shows a greater proportion of larger particles than (1), due to its inherent nature, to imperfect washing, or to both. The fact that it mixes less readily with water than (1), and shows greater dry strength, indicates that the particles are less highly hydrated and therefore closer together in the "dry" clay.

(3) *Florida Kaolin.* (This material also is of secondary origin and has properties very much akin to those of the Georgia kaolin and differs only in the quality of firing to a whiter color. The tensile strength of the Florida kaolin is about 100 pounds per square inch, the compressive strength about 530, and the transverse strength about 240 pounds per square inch in the dry state.)

Considering the geological history of Florida, this clay has probably been carried a long distance by prehistoric waters, and then thrown out by the precipitating action of the ocean. The gradual raising of the land and subsequent leaching by rain or flood waters would tend to remove pelagic salts, which are evidently easier to wash out than those infiltrated into the Georgia clay after its deposition.

(4) *North Carolina Kaolin.* (This kaolin is of strictly primary origin, being found in contact with the parent rock. It must undergo a very thorough washing process which is rather expensive, owing to the fact that the yield is only about 15 per cent. Although a primary kaolin it differs radically from the English china clay in being much coarser and practically lacking in colloidal material. At least the quantity of this portion is evidently

very low. This is shown by the low strength in the dried state. The tensile strength is not more than 70 pounds per square inch, the compressive strength about 340, and the transverse strength about 150 pounds per square inch. For the reasons stated this kaolin does not replace the English material since it lacks the gradation from the finest to the coarser particles possessed by the latter.)

The relatively large number of coarse particles in this clay, and its consequent deficiency by weight in colloidal material, account for its weakness when dry. To stretch the yield on washing, considerable coarse material has been included. The presence of coagulating salts is indicated by the slow colloidal motion, and by the yellow masses (apparently ferric hydroxide) absorbed by some of the large particles.

(5) *Tennessee Ball Clay No. 5.* (This clay is of secondary origin but has undergone much greater changes than the secondary kaolins like those from Georgia. It has evidently been brought in contact with organic matter from peat or lignite deposits which has entered into the clay structure. Furthermore, the composition has been changed still more by the infiltration of salts of iron giving rise to ferric hydroxide or pyrites. Through this action this clay has become very much more consolidated, stronger and more horn-like in appearance as may be readily observed by whittling a raw lump with a knife. While the primary and secondary kaolins are more or less chalky and earthy, the ball clays cut more with a hard and smooth surface resembling a horn substance. There is, therefore, a great difference between the kaolins and this type of clay. This may be observed at once also by the color which is no longer white or creamish but much darker and sometimes brown or even black. The strength of these clays as is to be expected is much greater than that of the kaolins and in addition this clay substance is able to bind together or bond a considerable amount of inert material, which can not be done by the kaolins. In other words, the ball clays have an excess of plasticity which enables them to do this; and hence they are exceedingly useful in glass refractories and other products in uniting the large quantity of calcined material which must be used. Owing to their dense structure these clays

dry more or less difficultly when used alone in larger masses owing to the exceedingly fine capillary system, which causes the flow of water from the interior to the exterior to be very slow. If, therefore, the evaporation on the surface is at all rapid a strain will be produced owing to the inability of the water to fill up the pore space emptied by evaporation as fast as the latter process takes place. This difficulty, of course, disappears at once when the clay is used to bond together inert matter. The strength of these clays when used alone is apparently not as great as it should be because of the fine fissures and cracks caused during the drying. When admixed with sand the real strength of the clay appears at once. Thus the tensile strength of such a ball clay alone may be 135 pounds per square inch, and when admixed with an equal weight of sand it may still show the same strength. In one case such a ball clay has a tensile strength of 128 pounds per square inch and when admixed with sand equal to its own weight the strength was 158 pounds, showing therefore an actual increase in spite of the admixture with 100 per cent of inert material. The compressive strength of these clays may vary from 600 to 1000 pounds per square inch alone and from 500 to 800 pounds when admixed with sand. The transverse strength of the clay alone usually fluctuates around 500 pounds per square inch.)

The absence of many large particles in this clay indicates its secondary origin, or else washing. The gel groups, slow colloidal motion, and marked crystalloidisis, show the presence of coagulants (iron salts and the diffusible products of their hydrolysis are highly coagulating), against which is probably balanced the protective or deflocculative action of organic extractives. This means great syneresis, which would tend to diminish the dry strength by cracks. However, on admixture with inert or calcined material, especially with an excess of water or on aging the clay may undergo further deflocculation, thus improving its binding strength; for dilution lessens the coagulating action of salts, and so forth, and with aging and agitation, tends to aid hydration and deflocculation.

The wetness of the 50 per cent solution of this clay indicates that the total free surface is small as compared with (1)–(4)–,

that is, the particles average larger; but pugging and blunging should improve its water absorbing properties.

(6) *Kentucky Ball Clay No. 4.* (This clay has also some of the characteristics of the Tennessee ball clay, but it differs somewhat with reference to the structure and plasticity. While the ball clay has usually been in contact with the recent coal and peat formations, clays of the Kentucky type have been subjected to greater pressure in contact with harder lignite deposits. Furthermore, it would seem that the content of iron pyrites is greater in the Kentucky type of clay than in the Tennessee type. The increased pressure has consolidated and indurated the clay much more thoroughly so that it comes from the mine in harder lumps, slaking somewhat more difficultly when brought in contact with water. In other words, this clay represents a transition from the true ball clay to the fire clay type. However, the strength of this clay does not differ appreciably from that of the Tennessee ball clay.)

The many large gel particles, hampered colloidal motion, and very marked crystalloidisis (with diplococci), are all in line with the history of pressure and high salt or coagulant content. The strong acidity may be due to H_2SO_4 differentially diffused out of ferrous sulphate, which readily undergoes hydrolysis. In consequence of the pressure and other aggregating factors, the clay is less readily miscible with water than (5). But its colloidal particles are small, and the large gel groups evidently have great water-taking capacity; for judging from its stickiness this clay has a somewhat greater total free surface than (5).

(7) *Illinois Kaolin.* (The first unwashed sample was marked Illinois Kaolin Co.—Plastic Clay.) (This clay has been misnamed since it is not a kaolin but a true ball clay, having properties very much like the Tennessee material and in fact is somewhat stronger. It has all the attributes of a ball clay, except that it is considerably lower in organic matter and comes from the mine in clean light colored lumps of considerable hardness. It must be considered a ball clay in every respect, however.)

This is evidently a ball clay which has undergone natural or else artificial washing and purification, for large particles are absent, although there are many small gel groups. The washing

has evidently removed some of the coagulating substances, for though the colloidal motion is hampered, there is no crystalloidisis and the clay is not as acid as (6), which it apparently surpasses in free surface.

(8) *Highland Fire Clay.* (This clay represents a type quite distinct from the ball clay in that it has been subjected to greater pressure and occurs in bituminous coal horizons and not with lignite. It is, therefore, consolidated to a considerably greater extent and requires slaking in air to develop its full plasticity. It also contains a considerable amount of iron pyrites which must be removed by washing. This type of clay is quite high in soluble salts, especially sulphates arising from the decomposition of pyrite, which cause the material to react but poorly with the alkaline reagents as regards deflocculation. It is customary to store the clay if possible for a long time so as to wash out the salts as much as possible. The mechanical strength in the dry state of these clays is considerable and at the same time their drying shrinkage is very much less than that of the ball clays. The clay, therefore, is a typical fire clay and has departed from the ball clay type even though its strength and bonding power are equally great. It is a curious fact that in spite of the presence of pyrites these clays do not filter press readily when fresh but do so after weathering for a year. The addition of a considerable amount of acid 0.05 to 0.1 per cent overcomes this deflocculated state and permits of filter pressing.)

The particles of this clay are all relatively large and apparently do not readily disintegrate, for the freshly mixed 50 per cent clay solution shows free water. Pressure, coagulating salts with the absence of organic deflocculators (which diffuse less readily from coal than from lignite), are all factors tending to the dehydration and close union of the clay particles. Since the clay does not take up much water, it should not shrink much in drying.

(9) *LaClede-Christy Bond Clay No. 69B.* (This is a mixture of unknown composition but presumably consisting of Missouri plastic clay such as the Highlands fire clay and Kentucky ball clay.)

The practical absence of large particles in this clay and the smallness and activity of its colloidal particles, indicate careful

washing and treatment to produce deflocculation, to remove flocculating substances, or both. The acidity indicates its precipitation after washing by some acid or acid salt. The clay consists mainly of small but not colloidal particles, and as its 50 per cent solution shows much free water, it should not show much drying shrinkage.

(10) *Plastic Bond Clay, Lester, Arkansas.* (The original sample was marked Plastic Clay, Camden, Arkansas.) (This material is unique in being the American duplicate of the famous Gross Almerode clay formerly imported from Germany for glass house refractories. It differs from most bond clays in being very high in finely divided quartz. The clay usually runs close to 75 per cent in silica. In spite of this siliceous character it possesses excellent plasticity and bonding power. The geological origin of this clay is tertiary but it appears to be a ball clay enriched with silica and underlies a lignite. I might add that this clay is of exceedingly great value and should be exploited commercially much more thoroughly than is being done at the present time.)

The large sharp crystal particles reported are evidently finely divided silica or quartz. The large size and slow motion of the colloidal particles and the marked crystalloidisis, agree with Mr. Bleininger's suggestion that it is a modified ball clay. The silica would tend to give the clay an interior space lattice, which would facilitate drying and equalize strains, and thus minimize drying shrinkage. The acidity and other factors, indicate much salts or the acid products of their hydrolysis.

(11) *Delaware Kaolin* (*Newark China Clay Co.*). (This clay is a primary kaolin, being found in contact with the parent rock in Maryland and Delaware. It is usually of a somewhat yellowish color due to its content of ferric oxide. In firing, however, it produces a color very much like that of the Georgia kaolin. Physically this kaolin is not as coarse as the North Carolina nor, of course, is it as fine as the Georgia and Florida secondary kaolins. However, it does not possess the gradation in sizes shown by the English china clay and therefore it can not be said to duplicate the latter. Its strength is somewhat greater than that of the North Carolina kaolin and less than that of the English. Admixed with North Carolina and Georgia kaolin it gives us a very

good porcelain body and in fact we have used it for this purpose very largely. It might be said that we can duplicate the English china clay through a mixture of these three clays very closely, but the unfortunate part from the economic standpoint is that both the North Carolina and Delaware kaolins are not available in large amounts. We are hence lacking in this country in primary kaolins; and in spite of what some say, this deficiency has not been made good up to the present time. No amount of treatment will convert the Georgia kaolin into a primary one of the Cornwall type. If we had in this country a larger supply of North Carolina kaolin the entire difficulty would be solved.)

This differs markedly from the English kaolin (1). It contains more large reticulated gel groups, and though its colloidal particles are small, their motion is hampered and they show marked crystalloidisis (with diplococci). Apparently this clay has possibilities unrealized because of entire absence of treatment, or perhaps because of improper treatment. It would seem that this clay, if scientifically handled, might be worked into a good substitute for English kaolin, at least for some purposes.

In conclusion I would remark that these preliminary ultramicroscopic examinations indicate that a thorough study of clays along the lines of colloid-chemical principles and analysis will throw much light upon many obscure phenomena met with by those who use clay for ceramic and other purposes. These factors extend their influence not only to the formative part of the ceramic process, but also to the subsequent drying, baking, and firing or burning; and their effects are traceable up to the zone of actual fusion.

RIDGEFIELD, CONN.

NOTICE—*Further discussion of this subject is solicited. All communications should be sent to the Editor.*

THE FUSIBILITY OF MIXTURES OF GRAPHITE ASH AND BOND CLAYS*[1]

By R. N. Long

It is generally considered that the refractoriness of the bond clay in graphite crucibles is materially reduced by the ash content of the graphite. Graphites for the manufacture of crucibles are graded for the market in terms of graphitic carbon or the percentage of ash which remains after the carbon has been ignited. Specifications[2] usually require not less than 85 per cent to 90 per cent graphitic carbon or not more than 10 per cent to 15 per cent ash. It is possble to refine the Ceylon variety to almost 100 per cent carbon[3] but as commonly prepared for crucible manufacture the best grades of lump seldom assay higher than 90 per cent carbon, while the chip grades, small percentages of which are sometimes used in crucibles, will fall as low as 70 per cent carbon. With the use of modern milling machinery Alabama producers are now marketing number 1 flake and number 2 flake which will compare favorably by chemical analysis[4] with the two Ceylon grades. Actual foundry tests[5] indicate that Ceylon graphite can be replaced by the Alabama flake without shortening the life of the crucible, although these tests were not sufficiently extensive to be conclusive. According to the most recent quotations[6] on graphite, Ceylon lump is now selling at 15 cents per pound and Alabama number 1 flake at 10 cents per pound.

*Read February 23, 1920, at the meeting of the American Ceramic Society in Convention at Philadelphia.

[1] By permission of the Director, U. S. Bureau of Mines.

[2] H. G. Ferguson, *Min. Res.* **1917**; *U. S. G. S.* **1918**, p. 97.

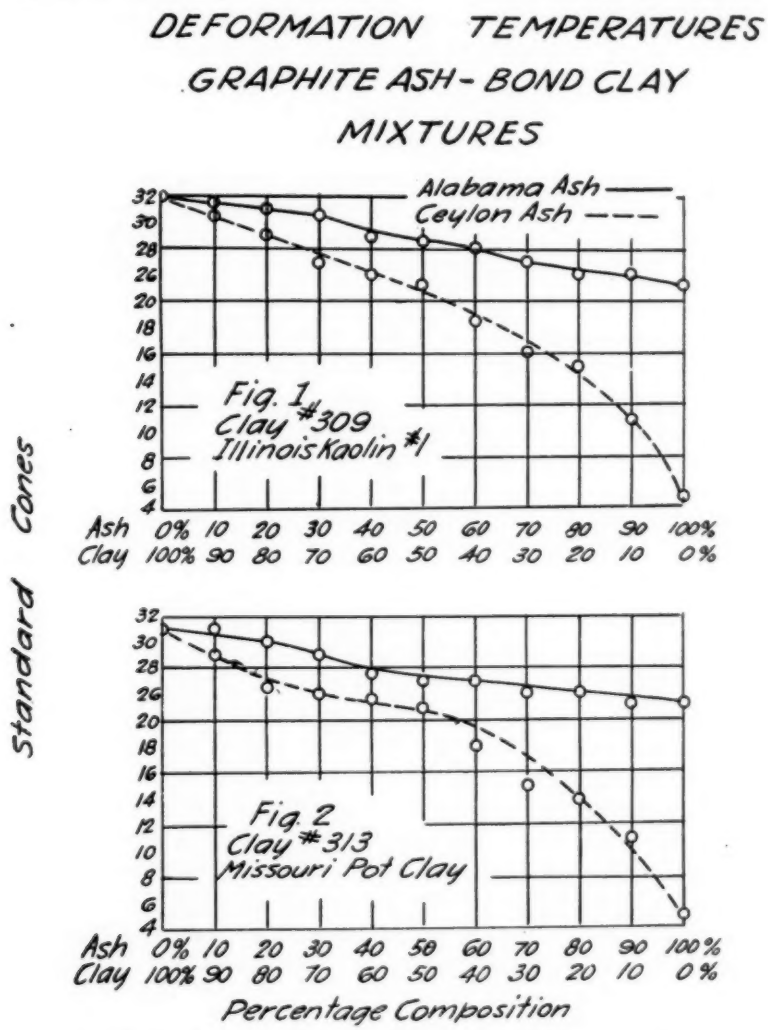
[3] H. P. H. Brummell, *Trans. Can. Min. Inst.* **22**, 1919.

[4] Geo. B. Dub, "Preparation of Crucible Graphites," War Min. Investigations, p. 21.

[5] R. T. Stull, "Crucibles Under Brass Foundry Practice," *Jour. Am. Ceram. Soc.*, **1919**, p. 224.

[6] *E. & M. Jour.*, p. 372, **109**, No. 5, January 31, 1920.

Tests[1] on 16 Alabama graphites have shown their ashes to be far more refractory than Ceylon ash. In a crucible this ash is


DEFORMATION TEMPERATURES
GRAPHITE ASH - BOND CLAY
MIXTURES
Alabama Ash
Ceylon Ash
Fig. 1
Clay #309
Illinois Kaolin #1
Fig. 2
Clay #313
Missouri Pot Clay
Standard Cones
32 30 28 26 20 18 16 14 12 10 8 6 4
Ash 0% 10 20 30 40 50 60 70 80 90 100%
Clay 100% 90 80 70 60 50 40 30 20 10 0%
Percentage Composition

gradually formed by the burning out of the carbon, and thus be-

[1] M. C. Booze, "Fusibility of Graphite Ash and Its Influence on the Refractoriness of Bond Clays," *Jour. Am. Ceram. Soc.*, **2**, 66 (1919).

comes free to exert any contact fluxing action it may possess, on the crucible body. A certain amount of fluxing may be beneficial, since the formation of a glaze on the surface of the crucibles retards further oxidation of the graphite and reduces the production of ash. Thus the life of the crucible is prolonged.

Some crucible users advocate the application of a flux or glaze to the surface of a new crucible to promote the formation of this protective coating. It would seem that the proper control of the ash content might assist in the glaze formation and make possible the use of graphite of a lower carbon content than is now considered permissible. Since there is very little demand for the more impure grades they can be purchased at a lower cost and crucibles produced which might be capable of developing a good glaze without reducing the refractoriness or value of the crucibles themselves, because the graphite must be oxidized before the ash can exert its fluxing action upon the clay.

Previous work on the fusibility of graphite ash[1] indicates that although the ash alone may show a comparatively low fusion point, it is not a very active flux in contact with the bond clay. Ceylon ash alone deformed at cone 2, but when 12 per cent of the ash was introduced into a bond clay, it reduced the refractoriness from cone 30 to cone 26, which is a safe temperature above that generally used in steel melting, and, therefore, far above that used in melting brass.

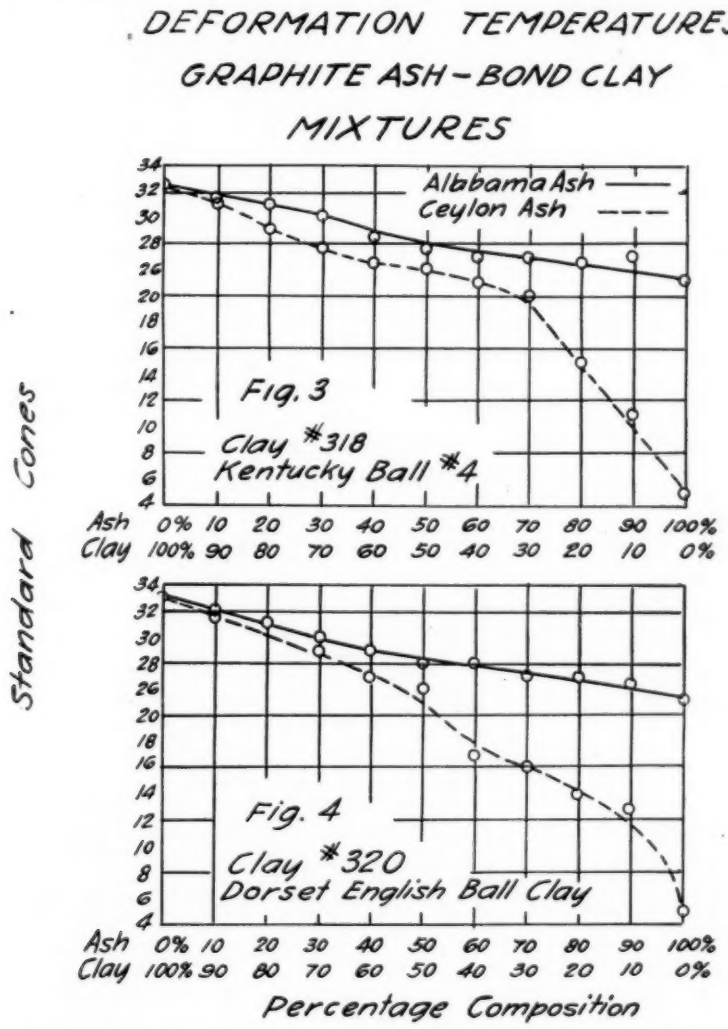
This investigation, following up the work of Mr. M. C. Booze, was undertaken to determine the effect of increased amounts of ash on the refractoriness of the bond clay, and to determine whether an eutectic existed between the graphite ash and the bond clay. If the 10 per cent to 15 per cent of ash generally present in the graphites used in manufacturing crucibles, does not lower the refractoriness of the bond clay sufficiently to be detrimental at brass and steel melting temperatures, the use of graphites higher in ash might be permissible in crucibles in so far as the refractoriness is concerned.

Laboratory Tests

A representative sample of Alabama ash was obtained by blending, in equal parts, six graphites which had been previously

[1] Booze, M. C., *loc. cit.*

sampled by quartering. This mixture, which consisted of three parts number 1 Alabama flake, two parts number 2 flake and one



part dust, was oxidized in a ventilated muffle kiln at 800 degrees C for several days. A sample of Ceylon crucible graphite was oxidized in the same manner.

From each of these ashes a small sample was forwarded to the Pittsburgh Station of the Bureau of Mines for analysis, the results of which are given in the following table:

	Ceylon ash Per cent	Alabama ash Per cent
SiO_2	55.2	56.12
Al_2O_3	27.4	33.9
Fe_2O_3	7.5	9.24
CaO	2.1	nil
MgO	1.2	0.04
Ignition loss[1]	0.4	0.13
	93.8	99.43

Standard sized cones were molded from the ash, using dextrine as a binder and the deformation temperatures determined in a gas-fired pot furnace, using compressed air. The flame was distributed by three small gas burners entering at angles nearly tangential. For the clay and ash mixtures, four domestic clays and two imported clays, Klingenberg (number 322) and Dorset English ball clay (number 320) were selected from those giving the best results in brass and steel melting crucibles tested.[2]

Cones were made of mixtures of Alabama ash and clay, and Ceylon ash and clay in a regular series from 10 per cent ash and 90 per cent clay to 90 per cent ash and 10 per cent clay, each intervening member of the series being 10 per cent richer in ash at the expense of the clay. The deformation temperatures of these mixtures and also of each clay alone are recorded in terms of standard cones, as shown in Table 2.

The sample of Ceylon ash had a comparatively low deformation point—cone 5, while the more refractory Alabama ash softened at cone 23+. The analyses of these ashes indicate that the Alabama ash is very low in alkali and alkali earths whereas these fluxes are comparatively high in the Ceylon ash, which is evidently responsible for its low deformation temperature.

[1] It may be assumed that the alkalies, sodium and potassium oxide, if determined, would bring up the total of the Ceylon ash. The alkali content of the Alabama ash is evidently low.

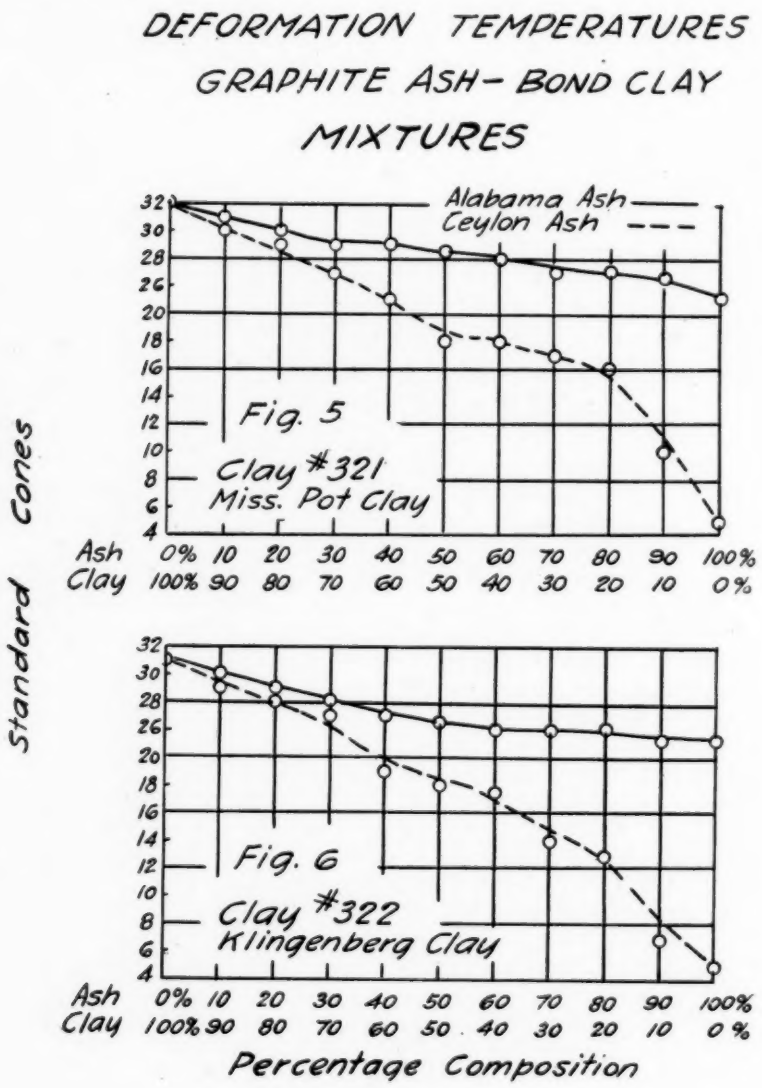
[2] R. T. Stull, "Behavior of Bond Clays in Crucibles Under Brass and Steel Melting Practice," *Jour. Am. Ceram. Soc.*, 1920.

TABLE 2—DEFORMATION POINTS OF MIXTURES OF GRAPHITE ASH AND BOND CLAY IN STANDARD CONES.

	Ash	0 Per cent	10 Per cent	20 Per cent	30 Per cent	40 Per cent	50 Per cent	60 Per cent	70 Per cent	80 Per cent	90 Per cent	100 Per cent
	Clay	100 Per cent	90 Per cent	80 Per cent	70 Per cent	60 Per cent	50 Per cent	40 Per cent	30 Per cent	20 Per cent	10 Per cent	0 Per cent
309	Ala.	32	31½	31	30½	29	28½	28	27	26	26	23+
	Cey.	32	30½	29	27	26	23+	18½	16	15	11	5
313	Ala.	31	31	30	29	27½	27	27	26	26	23+	23+
	Cey.	31	29	26½	26	26—	23	18	15	14	11	5
318	Ala.	32½	31½	31	30	28½	27½	27	27	26½	27	23+
	Cey.	32½	31	29	27½	26½	26	23	20	15	11	5
320	Ala.	33	32	31	30	29	28	28	27	27	26½	23+
	Cey.	33	31½	31	29	27	26	17	16	14	13	5
321	Ala.	32	31	30	29	29	28½	28	27	27	27	23+
	Cey.	32	30	29	27	23	18	18	17	16	10	5
322	Ala.	31	30	29	28	27	26½	26	26	26	23+	23+
	Cey.	31	29	28	27	19	18	17½	14	13	7	5

The cones of the clay-ash mixtures, unlike the ash alone, do not deform regularly but instead the tip of the cone generally bends stiffly until it is about halfway down and then hesitates until the temperature is increased 20 to 40 degrees. This is perhaps due to a tendency of these cones to swell, thus increasing their cross-section and stability. In determining the softening points, a time-temperature curve was followed as closely as possible, increasing the temperature at a rate of 10 to 15 degrees a minute, as suggested by the Committee on Standards. The slow rate of deforming of these cones slightly impaired the accuracy of their softening point determinations. The deformation of the clay-ash mixtures, with one exception, conform regularly to a gradually declining curve. With 100 per cent clay at the upper end, as the ash content increases, a slightly lower deformation temperature occurs until 100 per cent ash is reached as indicated, at the lower end of the curve. In the one exception the mixture, containing 90 per cent Alabama ash and 10 per cent number 318 clay, has a deformation of cone 27, which is slightly higher than that of the mixture of 80 per cent ash and 20 per cent clay. A second test checked the result of the first. There are no other irregularities or breaks in the curves and this one is not sufficiently marked to indicate an eutectic. The absence of eutectics might be expected

since the analyses of the ashes show a similarity to certain clay analyses. No clay-ash mixture shows a deformation temperature as low as the ash alone.



The fluxing action of the Ceylon ash is more marked than that of the Alabama in lowering the refractoriness of the bond clays, especially with the higher percentages of the Ceylon ash. As much as 90 per cent of the Alabama ash may be introduced into bond clays without lowering the fusion point of the mixture below cone 26, to which point it is lower by 30 to 40 per cent of the Ceylon ash. Since the ash in a crucible after the carbon has been burned out is not as intimately associated with the clay as it is in the cones tested, it is evident that the ash would be still less active as a flux in the crucible than the foregoing results indicate.

The behavior of the six clays, throughout the clay-ash mixtures is very similar. As a rule the bond clay with the highest initial refractoriness retains this lead over the less refractory clays in all the percentages of clay-ash mixtures. This would indicate that a larger percentage of ash could be used with a more refractory clay without lowering the fusibility of the mixture below that of a mixture containing a less refractory clay and a smaller percentage of ash.

Conclusions

In accordance with the findings of Mr. Booze, the ash from the Alabama graphite has a higher fusion point than the ash from the Ceylon and is less active as a flux in bond clay-ash mixtures.

No eutectic was found to exist between graphite ash and bond clay.

The action of these graphite ashes as a flux on bond clays indicates that graphite higher in ash than that now employed might be used in crucibles without seriously reducing the refractoriness.

Increased percentage of graphite ash in bond clay-ash mixtures lowers the refractoriness of the mixtures proportionately but does not destroy the initial advantage one clay may have over another in refractoriness.

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NOTICE—*Further discussion of this subject is solicited. All communications should be sent to the Editor.*

AN APPROXIMATE DETERMINATION OF THE MELTING-POINT DIAGRAM OF THE SYSTEM ZIRCONIA–SILICA[1,2]

By Edward W. Washburn and Earl E. Libman

1. Introduction

In order to form an intelligent opinion of the possibilities of manufacturing refractories containing zirconia as a principal constituent, the phase rule diagrams of the binary and ternary systems composed of zirconia with the other refractory oxides ought to be determined. The present investigation was intended to be the first one of a series dealing with this general problem, but the results obtained indicated that these diagrams probably all lie in the temperature region above 1700° C. The furnace equipment of our laboratory thus proved inadequate for the prosecution of such a study and as our resources were not sufficient to provide the necessary equipment, further investigation in this field has been abandoned. Since, however, there are at present in the literature no data whatever concerning melting point diagrams of systems containing zirconia, our preliminary results on the system zirconia–silica seem worthy of publication, although they leave much to be desired in the way of both accuracy and completeness.

2. Purification of Materials

The silica employed was a pure quartz powder of the quality used in the manufacture of optical glass.

The zirconia was obtained from a sample of zirconium hydroxide obtained from the Foote Mineral Company and having after ignition the following composition:

[1] Received February 27, 1920.

[2] Based upon the thesis of Earl E. Libman submitted to the Graduate School of the University of Illinois in partial fulfillment of the requirements for the degree of Master of Science, January 1920.

	Per cent
ZrO_2	99.17
SiO_2	0.05
MnO	0.06
Fe_2O_3	0.71
Al_2O_3	Trace
CaO	Trace
	99.99

In order to remove the 0.7 per cent of iron from the material, it was treated with phosgene gas. To test the efficiency of this method it was first tried out in a sample of baddeleyite having the following composition: ZrO_2, 79.16; SiO_2, 14.87; Fe_2O_3, 2.31; TiO_2, 1.79; and MnO, 1.76 per cent. The material was heated in a tube furnace at 300° C, while a current of $COCl_2$ was slowly passed through. Every two hours a sample was taken out and analyzed for SiO_2 and Fe_2O_3. The results obtained are given in table 1.

TABLE 1.—ILLUSTRATING THE EFFICIENCY OF THE PHOSGENE PROCESS FOR REMOVING IRON FROM ZIRCONIA

Sample	No. 1	No. 2	No. 3	No. 4
Hours in $COCl_2$ at 300° C	2	4	6	8
% SiO_2	14.76	13.89	13.52	11.96
% Fe_2O_3	2.00	1.03	0.02	Tr.

Qualitative tests showed fair amounts of both TiO_2 and MnO_2 still left in the material.

The excellent results obtained above warranted the treatment of the specially purified material in the same manner. In this manner the last traces of iron were removed from the zirconia so that portions fused with sodium carbonate, dissolved in hydrochloric acid, and tested with sulphocyanate gave no coloration.

3. Preparation of the Fusion Mixtures

The melting temperatures of pure ZrO_2 and of seven mixtures of ZrO_2 and SiO_2 were investigated. The mixtures were made up in the following molecular proportions: 1 ZrO_2.1 SiO_2; 1 ZrO_2.2 SiO_2; 1 ZrO_2.3 SiO_2; 2 ZrO_2.3 SiO_2; 1 SiO_2.2 ZrO_2; 1 SiO_2.3 ZrO_2; and 2 SiO_2.3 ZrO_2.

The required amounts of ZrO_2 and SiO_2 were carefully weighed and ground together for four hours in an agate mortar. The well mixed powder was then fused in a graphite crucible in a small arc furnace and the extremely hard crystals reduced to a coarse powder in a hardened steel mortar. The mixture was next ground extremely fine in a hardened steel mortar, and the impalpable powder thus obtained was boiled for several hours with dilute HCl under a reflux condenser to remove any particles of iron which might have been introduced from the steel mortar. The powder was then removed from the acid by filtration with suction, using a Büchner funnel, and washed with cold water until the washings gave no coloration with KSCN. This grinding, fusion, regrinding, extracting with dilute HCl, and washing free from iron was repeated *three times* with each mixture.

The final product was in each case a dark gray powder. The color was due to carbon either as such or in the form of carbide, and upon burning at a bright cherry red in a stream of oxygen gas the mixtures came from the furnace a pure snow white.

A portion of each mixture was made into sticks in the following manner. A line of the powder was spilled on a carbon plate and shaped with two spatulas until it had a triangular section. This was then slowly passed under a thirty-ampere A. C. electric arc, which gave a stick fused on the upper side. The stick was then turned over so as to expose the unfused side, and again passed through the arc. The result was a well fused crystalline pencil of the material about two inches long and one-eighth inch in diameter.

4. The Melting Point Apparatus

The melting points of the sticks were determined by feeding them slowly into an oxyacetylene flame and noting with the aid of an optical pyrometer the temperature of the small droplets of fused material which formed at the tip of the stick. This procedure apparently did not produce the eutectic melt as would have resulted from a slower rate of heating, but gave instead a melt having the same composition as the stick, owing to the small region which was subjected to the high temperature. The spherical droplets obtained were not, however, analyzed as the

roughness of the method and of the temperature measurements hardly made it worth while.

A diagram of the apparatus is shown in figure 1. The optical

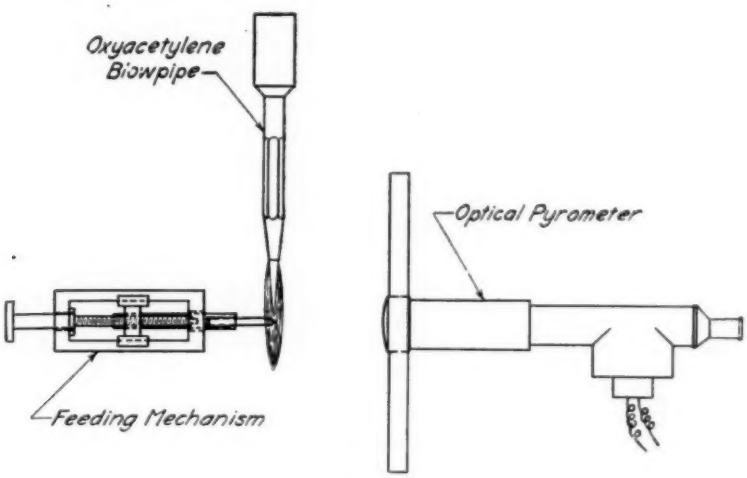

FIG. 1.

pyrometer employed was a Leeds and Northrup instrument of the Holborn-Kurlbaum type calibrated for us by the Bureau of Standards. The temperature readings could be duplicated to about $\pm 100°$.

5. The Melting Point Data

The melting points of the various mixtures secured in this way are shown in table 2 and the corresponding melting point diagram in figure 2.

It will be noticed that the diagram shows the presence of a compound corresponding in composition to the natural mineral zircon and having the same melting point.

A heavy black line is drawn in the figure separating the mixtures on the SiO_2 side from those on the ZrO_2 side. The mixtures on the ZrO_2 side of this compound are obviously composed of ZrO_2 and $ZrSiO_4$. These mixtures melted sharply and were very fluid, the drops forming readily and breaking away im-

TABLE 2.—MELTING POINTS IN THE SYSTEM ZrO_2–SiO_2

Composition	"Black body" temperature C°
ZrO_2	2470
3 ZrO_2 / 1 SiO_2	2435
2 ZrO_2 / 1 SiO_2	2400
3 ZrO_2 / 2 SiO_2	2210
1 ZrO_2 / 1 SiO_2	2300
Natural Zircon*	2300
2 ZrO_2 / 3 SiO_2	2170
1 ZrO_2 / 2 SiO_2	2170
1 ZrO_2 / 3 SiO_2	2170

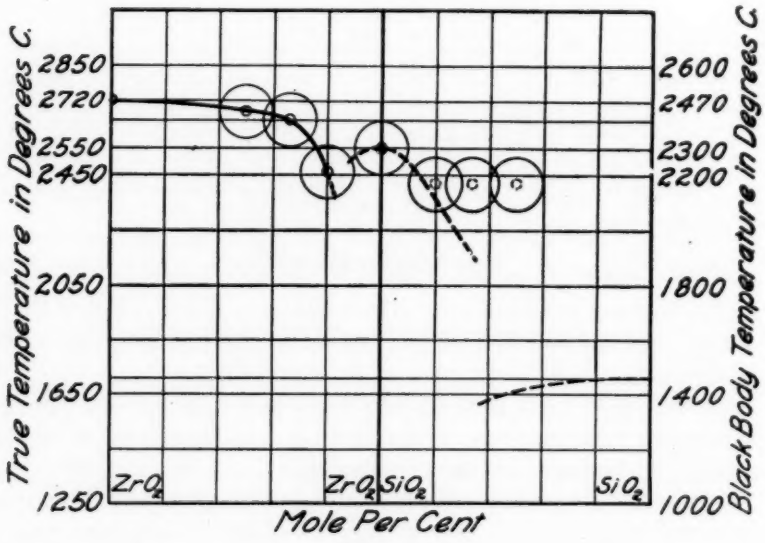

FIG. 2.

*The sample of mineral used in this determination was light yellow in color, but burned to a pure white in the flame.

mediately. On examination after cooling, they were found to be perfect spheres, showing complete liquefaction.

The mixtures on the SiO_2 side are obviously composed of SiO_2 and $ZrSiO_4$. These fused with difficulty, the fused material did not fall off but hung down from the main stick in threads, and examination after cooling did not reveal the spherical form noticeable with the mixtures on the ZrO_2 side. It is evident that the method employed is applicable only to mixtures that do not possess too high a viscosity. For this reason no reliance can be placed on the data obtained here for mixtures containing excess of SiO_2. The true melting points must evidently lie lower than those recorded.

6. True Temperatures

The temperatures given in table 2 and indicated on the right hand side of the diagram in figure 2 are "black body temperatures" that is, they represent the temperatures to which a "black body" would have to be heated in order to give the same pyrometer readings as those actually obtained. The true temperatures are probably considerably higher than those indicated by the pyrometer.

In order to estimate the magnitude of the correction which should be applied in order to convert the observed readings into true temperatures, the melting points of CaO and of MgO were determined with the same apparatus, with the following results:

CaO obs. m. p. 2370°, true m. p. 2570°, corr. 200°
MgO obs. m. p. 2470°, true m. p. 2800°, corr. 330°

By assuming a correction (250°) of the same order of magnitude for the mixtures used in this investigation, the "true temperatures" shown on the left-hand side of the diagram in figure 2 were obtained. They are perhaps correct within the accuracy of the data themselves.

7. Conclusions

From the diagram shown in figure 2 the following conclusions may be drawn:

(1) For use as a refractory up to about 2550° the presence of silica as an "impurity" in zirconia is not necessarily detri-

mental since the fluxing action of this impurity can be eliminated by adding enough more silica to bring its total content up to 33 per cent.

While such a refractory will be nearly as resistant to high temperatures as the pure zirconia itself, its other physical and chemical properties will, of course, be those of zirconium silicate which for some purposes might make it a less desirable refractory than the oxide. So little is known concerning the properties of the silicate, however, that further comparison of the two materials is not possible at present.

(2) The diagram also suggests that refractories of considerable strength might possibly be manufactured from powdered zircon bonded with a small quantity of a mixture of zirconium hydroxide and precipitated silica in molecular proportions and fired in an electric furnace.

Summary

1. The melting point of pure ZrO_2 is about 2700° C.

2. The melting point of the natural mineral zircon is about 2550° C. A mixture of ZrO_2 and SiO_2 in molecular proportions melts at the same temperature as the natural mineral.

3. A eutectic between ZrO_2 and $ZrSiO_4$ occurs in the neighborhood of 2300° C.

4. Iron may be completely removed from zirconia by heating it to 300° in a current of phosgene.

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Notice—*Further discussion of this subject is solicited. All communications should be sent to the Editor.*

THE EFFECT OF THE SIZE OF GROG GRAIN IN A TERRA COTTA BODY*

By H. E. Davis

In beginning a study of this kind, it was found profitable to refer to what work had already been done along this, or similar lines. Below is given a brief combined summary of the following references: "Notes on Action of Grog in Ceramic Bodies," by S. Giesjbeck, *Trans. Am. Ceram. Soc.*, Vol. **17.** "Effect of Grog in a Fire Clay Body," by Fulton and Montgomery, *Trans. Am. Ceram. Soc.*, Vol. **17,** and "Effect of Size of Grog in a Fire Clay Body," by F. A. Kirkpatrick, *Trans. Am. Ceram. Soc.*, Vol. **19.**

Grog may be defined as burnt clay, or its burnt products in the ground state, coarse or fine, according to the use to which it is put. The principal functions of grog in a clay body are: (1) To counteract both drying and burning shrinkage. (2) To decrease plasticity. (3) To insure safer drying and burning.

Previous studies, in general, working in all cases with refractory fire-clays, have reached the following conclusions: (1) With increasing grog amount, water of plasticity, shrinkage, dry and burned strengths decrease. (2) With increasing grog amount, porosity and absorption increase.

Kirkpatrick in his study (*Trans. Am. Ceram. Soc.*, Vol. **19**), keeping the amount constant, and varying the size, found practically the same results with increasing sizes as others found with increasing amount.

In studying the effect of grog, which plays so important a part in all the cruder clay wares, there may be five variables—amount of grog, kind of grog, shape of grain, size of grog particle, and relative proportion of sizes. In this study the size of particle has been the only one considered, all others remaining constant.

The object of this study has been to determine the effects of various separate sizes of grog particle upon a terra cotta body with

*Received February 27, 1920.

regards to raw and burned strength, dry and total linear shrinkage, water of plasticity, absorption of the burned body, smoothness of texture, and adaptability to taking a slip coating.

Body Materials.—The material used for grog was broken saggers from an electrical porcelain plant, having been repeatedly fired to cone 12. The grog was ground in a dry pan and screened into various sizes with standard screens. The sizes of grog selected were: 10–16-mesh, 16–20-mesh, 20–30-mesh, 30–35-mesh, 35–48-mesh, 48–65-mesh, 65–100-mesh, and 100-dust. The clays used were Dogtown, N. J. sagger clay, a very soft red clay, burning to buff under good oxidizing conditions, and Zanesville stoneware clay, an extremely hard gray colored clay burning to a good buff. The clays were broken up in a set of rolls until the maximum size would probably pass a 6-mesh screen.

Body Mixtures.—The bodies for the trials were made containing 40 per cent grog, 40 per cent Zanesville stoneware clay, and 20 per cent Dogtown sagger clay. This made eight bodies, and for purposes of comparison with conditions which probably would obtain in factory practice, a ninth body was made of the same proportions, the grog ingredient, however, containing all material passing a 10-mesh screen. For purposes of further comparison, a few bars were made from each of the individual clays, containing no grog, and also a mixture of the two clays in the proportions used throughout. All bodies containing grog were first mixed with water by hand and worked a while in this manner. They were then run several times through a set of rolls, set sufficiently far apart so as to effect no crushing action upon the grog particles. After considerable hand wedging, the samples were hand pressed in a brass mold into bars $1 \times 1^1/_8 \times 8$ inches. Also flat pieces about $1 \times 2^1/_2 \times 5$ inches were pressed in plaster molds and finished. The bars were used for shrinkage measurements, breaking strength and absorption; the flat pieces for surface texture and slip coating. A separate ball was made for determining the water of plasticity.

Drying and Burning.—Eighteen bars were made from each body, except the 100 per cent clay bodies, of which only seven

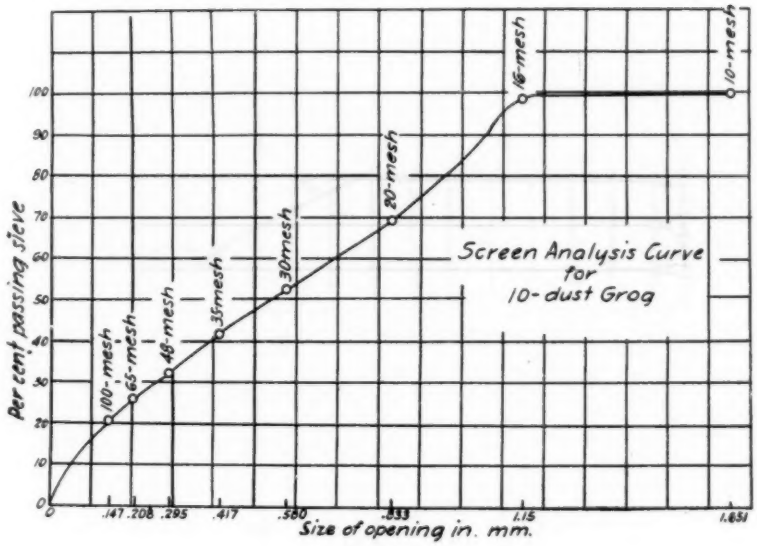

Per cent passing sieve
Size of opening in. mm.
100-mesh
65-mesh
48-mesh
35mesh
30mesh
20-mesh
16-mesh
10-mesh
Screen Analysis Curve
for
10-dust Grog

FIG. 1.

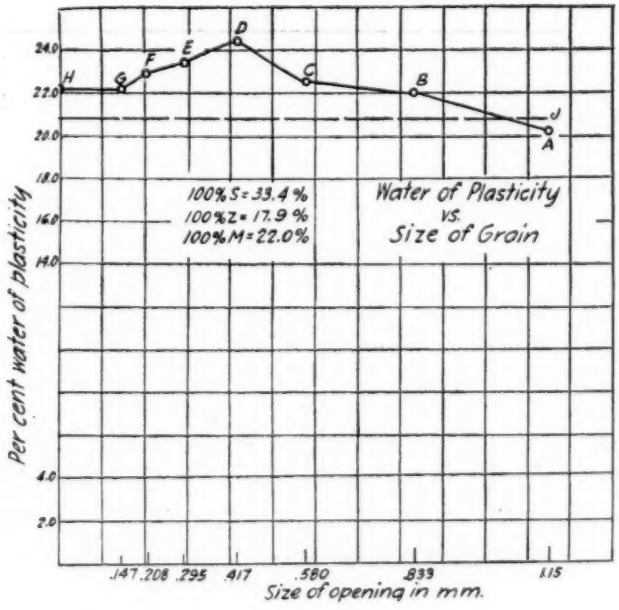

Per cent water of plasticity
Size of opening in mm.
100% S = 33.4 %
100% Z = 17.9 %
100% M = 22.0%
Water of Plasticity
VS.
Size of Grain

FIG. 2.

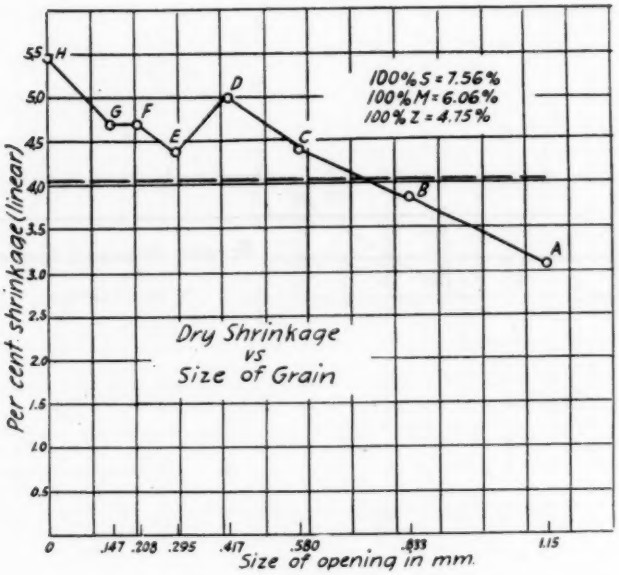

100% S = 7.56%
100% M = 6.06%
100% Z = 4.75%
Dry Shrinkage
vs
Size of Grain
Per cent. shrinkage (linear)
Size of opening in mm.
H
G
F
E
D
C
B
A
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0
.147
.208
.295
.417
.580
.833
1.15

FIG. 3.

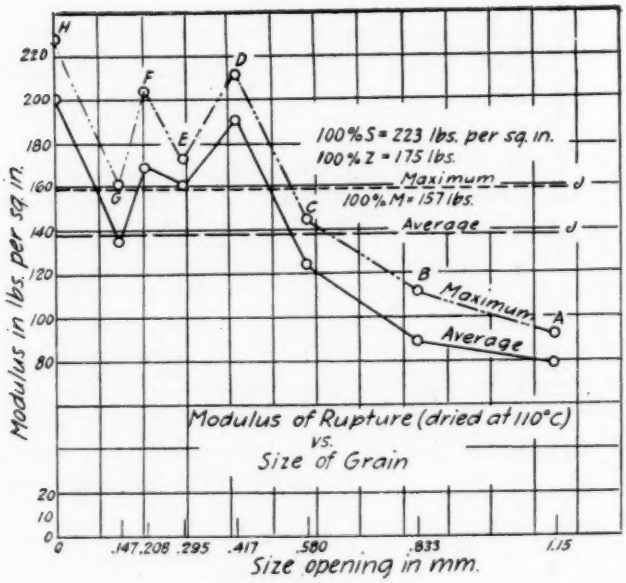

100% S = 223 lbs. per sq. in.
100% Z = 175 lbs.
Maximum
100% M = 157 lbs.
Average
Maximum
Average
Modulus of Rupture (dried at 110°C)
vs.
Size of Grain
Modulus in lbs. per sq. in.
Size opening in mm.
H
G
F
E
D
C
B
A
220
200
180
160
140
120
100
80
20
10
0
.147
.208
.295
.417
.580
.833
1.15

FIG. 4

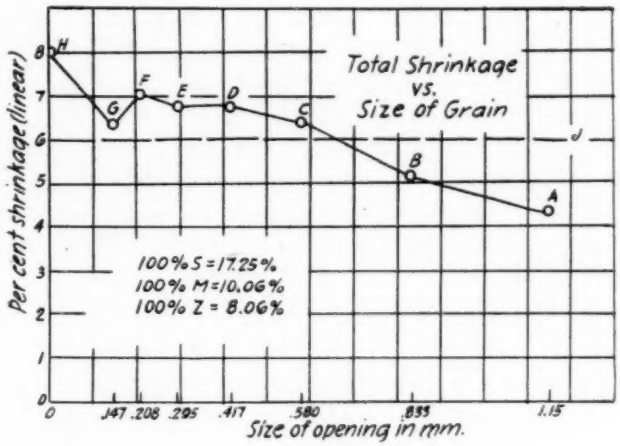

Total Shrinkage
VS.
Size of Grain
Per cent shrinkage (linear)
Size of opening in mm.
100% S = 17.25%
100% M = 10.06%
100% Z = 8.06%
H
G
F
E
D
C
B
A
J
0
.147
.208
.295
.417
.580
.833
1.15

FIG. 5.

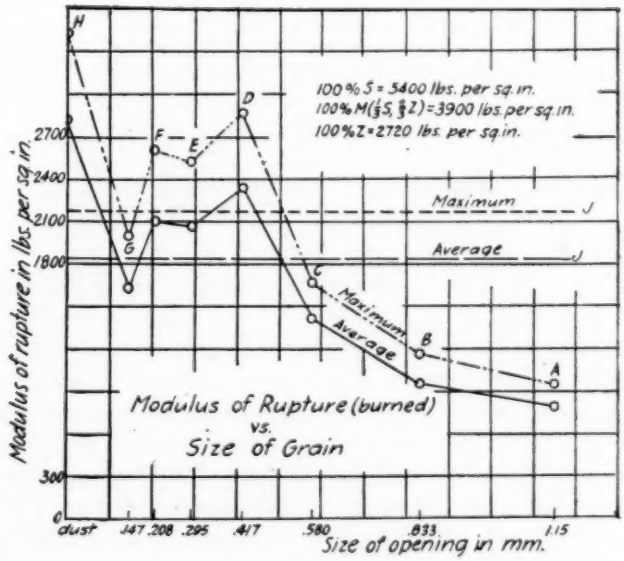

Modulus of Rupture (burned)
VS.
Size of Grain
Modulus of rupture in lbs. per sq. in.
Size of opening in mm.
100% S = 5400 lbs. per sq. in.
100% M (⅓S, ⅔Z) = 3900 lbs. per sq. in.
100% Z = 2720 lbs. per sq. in.
Maximum
Average
Maximum
Average
H
G
F
E
D
C
B
A
J
2700
2400
2100
1800
300
0
dust
.147
.208
.295
.417
.580
.833
1.15

FIG. 6.

bars each were made. Eight bars were taken from each set, air dried to constant weight, and then dried at 110° C to constant weight, while the remainder of the bars were burned. Four of the flat pieces were made and all were sprayed with a standard vitreous slip of the following composition: Flint 20, Cornwall stone 45, English ball clay 10, and English china clay 25 per cent.

The bars were placed in saggers, each sagger containing bars from every series, and a plaque of cone tips. These saggers, and those containing the slip coated trials, were burned in a small gas-fired test kiln. Unfortunately the burn resulted in a range of

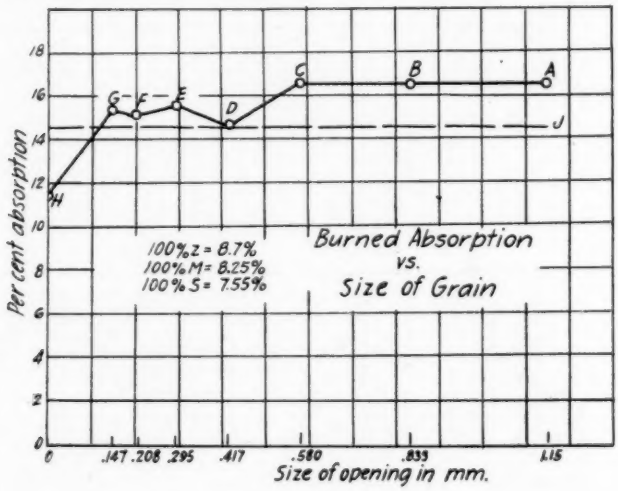


FIG. 7.

practically four cones, the lowest being a little below cone 2, and the highest a little above cone 5. The temperatures in the four saggers used were as follows: Cone 1–2, cone 2 good, cone 3, and cone 5–6. Since each sagger contained bars from every series, discrepancies in results, due to this temperature difference, were offset and the results are comparable, as all averages are based on figures extending throughout the range. Accurate account was kept, however, of the temperature to which each bar was burned, and, as might be expected, a gradual increase in strength and decrease of absorption was noticed with increasing vitrification, but no appreciable difference in shrinkage.

Methods of Testing.—Dry Trials. The eight bars from each series, having been dried at 110 degrees C, were measured for linear shrinkage, and broken on a standard Riehle briquette breaking machine, equipped with a transverse breaking attachment designed at the U. S. Bureau of Mines. Bars were broken on a 5-inch span and the halves on a 3-inch span. The water of plasticity balls were also dried at 110 degrees C and reweighed to determine the loss. No bars were counted into the average in either dried or burned calculations, whose strength figured below 70 per cent of the maximum.

Burned Trials. The burned bars were measured for shrinkage in the same manner, and broken in the same machine on 5-inch and 3-inch spans, after adjusting the machine to accommodate the much greater load. Three pieces of broken bar, one from low, high and medium fire, were selected from each series for absorption trials. These were weighed and put into a pan of water. They soaked in cold water over forty hours and were then boiled for about two hours, and reweighed.

Methods of Calculation.—(1) Per cent linear shrinkage was figured on the basis of the plastic or original length.

(2) Per cent water of plasticity or tempering water =

$$\frac{\text{Plastic weight} - \text{dry weight}}{\text{dry weight}} \times 100$$

(3) Modulus of rupture or transverse strength in pounds per square inch $= \frac{3\ P\ L}{2\ b\ d^2}$, where P = load in pounds, L = span in inches, b = breadth of bar and d = depth.

(4) Per cent absorption $= \frac{W - D}{D} \times 100$, where W = wet weight and D = dry weight.

In order to make the reading of blue prints and tables easier, the bodies have been lettered according to the following system:

S = 100 per cent Dogtown sagger clay body.

Z = 100 per cent Zanesville stoneware body.

M = $66^2/_3$ per cent of Z and $33^1/_3$ per cent of S.

Body mixtures are as follows:

Body	Grog Per cent		Dogtown Sagger clay Per cent	Zanesville clay Per cent
A	40	10–16 mesh	20	40
B	40	16–20 mesh	20	40
C	40	20–30 mesh	20	40
D	40	30–35 mesh	20	40
E	40	35–48 mesh	20	40
F	40	48–65 mesh	20	40
G	40	65–100 mesh	20	40
H	40	100–dust	20	40
J	40	10–dust	20	40

SCREEN ANALYSIS OF J-GROG[1]

(Per cents are per cents retained)

16 mesh.....	0.60	48 mesh.....	9.50
20 mesh.....	30.40	65 mesh.....	6.30
30 mesh.....	17.10	100 mesh.....	5.40
35 mesh.....	10.50	—100 mesh.....	20.20

Tables.—Tables 1 and 2 give the average figures in the various properties of the bodies based over the entire range of temperature, while tables 3 and 4 show the variation of strength and absorption due to increased vitrification.

TABLE 1—DRY TRIALS

Body	Per cent water of plasticity	Per cent dry linear shrinkage	Average modulus of rupture lbs. per sq. in.	Maximum modulus of rupture lbs. per sq. in.
100% S	33.4	7.56	223	250
100% Z	17.9	4.75	175	200
33 1/3% S, 66 2/3% Z	22.0	6.06	157	188
A	20.37	3.1	79.2	92.5
B	22.03	3.85	89.2	112
C	22.60	4.4	124	145
D	24.45	5.0	190	212
E	23.46	4.36	160	173
F	23.00	4.7	169	204
G	22.20	4.7	135	161
H	22.20	5.45	202	228
J	20.8	4.06	138	159

[1] The base line of all curves, marked size of opening in millimeters, refers to the size of opening upon which the grog was retained and not the last size through which it passed. The sizes are taken from the Tyler Standard Screen Scale with the exception of the size 1.15 (16-mesh) and the size 0.580 (30-mesh).

TABLE 2—BURNED TRIALS

Body	Per cent total linear shrinkage	Average modulus of rupture lbs. per sq. in.	Maximum modulus of rupture lbs. per sq. in.	Per cent absorption
100% S	17.25	4745	5400	7.55
100% Z	8.06	2530	2720	8.7
$33^1/_3$% S, $66^2/_3$% Z	10.06	3410	3900	8.25
A	4.36	804	960	16.51
B	5.14	960	1190	16.47
C	6.4	1420	1670	16.53
D	6.75	2330	2870	14.60
E	6.72	2070	2520	15.5
F	7.045	2100	2610	15.1
G	6.375	1635	2020	15.32
H	7.95	2815	3430	11.40
J	6.0	1836	2170	14.50

TABLE 3—STRENGTH AGAINST TEMPERATURE

Body	Strength at cone 2—	Strength at cone 2	Strength at cone 3	Strength at cone 5+
A	705	764	826	805
B	910	964	1000	1127
C	1346	1441	1387	1537
D	2253	2031	2338	2475
E	1886	1956	2011	2210
F	1939	1916	2157	2268
G	1552	1485	1535	1721
H	2551	2478	2770	2787
J	1706	1752	1762	1817

TABLE 4—ABSORPTION AGAINST TEMPERATURE

Body	Per cent absorption cone 2—	Per cent absorption cone 3	Per cent absorption cone 5+
A	17.00	16.95	15.6
B	16.70	16.70	16.0
C	17.00	16.60	16.0
D	14.9	14.5	14.3
E	15.9	15.4	15.2
F	15.1	15.60	14.6
G	15.45	15.50	15.0
H	11.60	12.00	10.60
J	14.7	14.6	14.2

Summary of Data

1. **Tempering Water *versus* Size of Grain.**—Results show increasing water of plasticity with finer grog, up to a maximum at

D (30–35 mesh), and decreasing water of plasticity from this point to H (100-dust).

The J (10-dust) body required less tempering water than all others with the exception of the coarsest grog body.

The range throughout the series is 4.07 per cent, and the average for the group is about 22.35 per cent.

2. Dry Linear Shrinkage.—In general, shrinkage increases with fineness of grog grains throughout. There were two exceptions to this conclusion, which should be checked before a definite statement can be made. The D body was abnormally high, and the E body slightly low.

The range is 2.35 per cent and the average shrinkage is 4.43 per cent.

3. Dry Transverse Strength.—In general, results show an increase in strength with finer grain. There are two exceptions here also; D body, which is abnormally high, and G body, which is abnormally low. The strength of the 10-dust body is about an average of the entire series.

The presence of coarse grog lowers very materially the strength of the mixture of clays alone, or the single clays.

4. Total Linear Shrinkage.—The results show a very even tendency toward increased shrinkage with finer grains, duplicating the dry linear shrinkage curve. There was but one exception here, the G body, which ran low. The position of the 10-dust body in dry shrinkage is duplicated in total shrinkage. The presence of 40 per cent grog cut down the shrinkage of the clay mixture alone by from 30 to nearly 50 per cent, depending upon the size of grog.

5. Burned Transverse Strength.—The relative strengths of bodies in the dried state remains unchanged after burning. The relative position of the 10-dust body also remains practically constant. There is a considerable lowering in strength from the mixture of clays alone, down to even the strongest of grog mixtures.

The range in strengths is from 804 to 2815, and the average is 1767 pounds per square inch. The 10-dust body lies slightly above this average.

6. Burned Absorption.—The results show a general tendency toward decreased absorption with finer grain after passing the 20–30 mesh body. There are two slight exceptions in this curve. The D body, and the F body, both of which fall slightly low. Absorption ranges from 11.40 to 16.53 per cent, or 5.13 per cent difference. The absorption of the raw clay mixture is greatly increased by the addition of 40 per cent grog. The average absorption is 15.10 per cent or an increase of 83 per cent over that of the raw clay mixture.

Study of Slip-Coated Trials.—The bodies showing fine cracks and crow-footing were those containing the coarse grog, 10–16 mesh, 16–20 mesh, 20–30 mesh, and the 10-dust body, which may be seen from the screen analysis to be a fairly coarse grog. All other bodies were of smooth, unbroken surface. As the bodies showing cracks are also the weaker bodies, we may safely conclude that strength and compactness, or freedom from cracks go hand in hand. Where strength can not readily be determined, this seems, from the above conclusion, like a very good indicator of comparative strengths of bodies. As an example, the 10-dust body and the 30–35 mesh body may be compared. The 30–35 mesh body showed no cracks and has a very high strength while the 10-dust body showed considerable cracking and was weaker in the breaking test. Although the fine cracks may be noticed in the uncovered body, the slip coating greatly emphasizes their presence.

General Conclusions

In drawing some general conclusions from the results of this research, it seems that to develop good strength, both burned and dry, the grog ingredient should contain a rather large amount of fine material as the coarser material cracks and thus weakens the body. Fine grog is also very desirable in a slip covered body, as by this means a close-fitting smooth surfaced vitreous coating may be obtained, which will stand up well under the strain of weathering. Further study is necessary, however, to determine the best means of proportioning fine and coarse material in the grog ingredient.

NORTHWESTERN TERRA COTTA COMPANY
CHICAGO, ILL.

Discussion

MR. R. L. CLARE: This paper should be of great advantage to all Terra Cotta Manufacturers in tracing the source of some of their difficulties, such as variation in shrinkage or cracking.

They should realize from reading the results of this investigation, the wide variations in the properties of the body that can occur from a change in the grog size only. If this one property of the grog could be properly controlled, a great improvement would be noted in the uniformity of the material produced.

NOTICE—*Further discussion of this subject is solicited. All communications should be sent to the Editor.*

THE ART OF POT MAKING[1]

By Chas. O. Grafton

The different methods and operations necessary in the manufacture of a glass melting pot are so numerous that it is impossible to go into detail regarding them all, and this article will only touch on the important items.

The most important factor in the manufacture of a clay pot is the proper selection of the clays of which the pot is to be made. Prior to the beginning of the war in 1914, and as far back as the writer can remember, we were all laboring under the false impression that good clay pots could not be made except when German clay was used. When the war started the importations of German clay were suddenly cut off, and pot manufacturers were compelled to substitute American clay for the German. The big mistake was made of attempting to substitute one single American clay for the German. To date, it has not been the writer's good fortune to discover a single American clay that is a perfect substitute for the German clay, but by blending three American clays, not only is a satisfactory substitute obtained, but in many cases a clay superior to the German clay is produced.

Mixing.—With the clay is added a proportion of calcined clay and pot shell from the old pots, from which the glass and vitrified parts have been carefully removed. As a large proportion of the old pot shell is used, the cleaner it is kept the better; and the glass manufacturers will aid materially in improving the quality of pots by keeping the pot shell as clean and as free from dirt as possible by providing suitable storage for the shell.

The batch, consisting of proper proportions of clay and shell, is thoroughly mixed, slowly run into a mixer and water is added. After it leaves the mixer it drops into a pug mill and is again thoroughly mixed and worked and packed firmly together.

Ageing Pits.—The batch is then carried to the ageing pits, where it is stored away to age for a period of twelve weeks. After

[1] Received February 27, 1920.

many years of experimenting with different periods of ageing, the writer has found that the advantage gained by ageing clay longer than twelve weeks is so little that it does not pay to carry the ageing to a greater length of time. The clay in the ageing pit is carefully covered with canvas, over which are placed heavy sacks and these are kept continually dampened throughout the period of ageing. (See figure 1.)

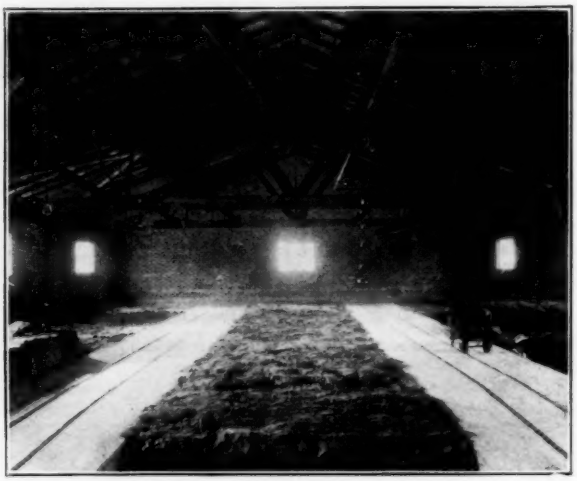


FIG. 1.—Ageing pits.

After the clay has reached its proper age, it is taken from the ageing pits and run through pug mills or wet-pans and is then given the final work of preparation—that of tramping it with the feet.

Tramping Clay.—The advantage gained from tramping clay is that the clay tramper's feet become as sensitive to the feel of the clay as the pot maker's hands, and the clay tramper becomes as proficient in the work of getting the clay to the proper consistency as the potter would in wadding his clay for the potter's wheel. (See figure 2).

Starting a Bottom.—The first operation in the actual work in the making of the pot is the laying of the bottom. The bottom

of an average pot when dry is four and one-half inches thick. It is formed in four layers, each layer being about one and one-fourth inches thick. The first layer is laid lengthwise of the board, and the next layer crosses it at right angles, and then the next layer lengthwise and the next again crosses it at right angles. The method of laying by hand consists of taking a piece of clay

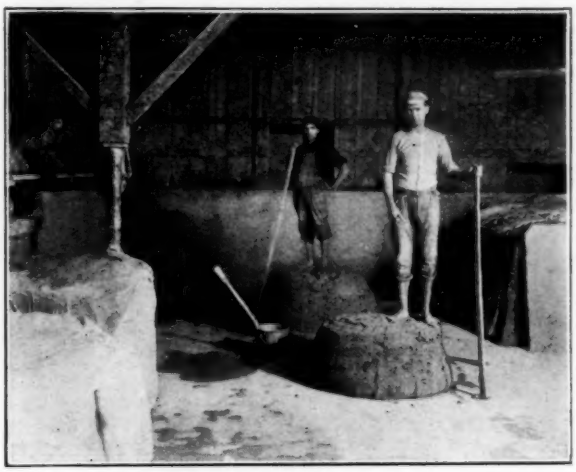


FIG. 2.—Tramping clay.

approximately 12 by 3 inches in diameter in the hands and throwing the weight of the body on the clay so it will spread out to the proper thickness. It requires about thirty of these rolls for each layer of the bottom. After the bottom is laid it is beaten off to the proper thickness and cut off to a pattern corresponding to the shape of the pot.

Turning Bottoms.—The bottom is then turned over as shown in figure 3, and placed on the board on which the pot is to be built. The board is usually made of heavy timbers with two layers of 2 × 12-inch boards on top of the timbers, and faced with plaster of Paris. On top of the plaster of Paris a small portion of coarsely ground shell is thrown, which enables the pot to shrink or crawl in when drying. An average sized pot, say

44 inches wide by 58 inches long, will shrink one and one-half inches in width and two inches in length. Inasmuch as the bottom of the pot is not exposed to the air, it is necessary to use some other means to dry it. Steam lines run under the bottom boards are very effective; electric lights while being rather expensive, are often used. The most effective method found by

FIG. 3.—Turning the bottom of a glass pot.

the writer has been the placing of a common burlap sack sewed up in a muslin envelope over the bottom of the pot. These sacks are changed several times a day and after being taken from the pots are placed in a dry room or over radiators to dry before being used again.

Working Hand Courses.—After the pot has been cut off and the bevel edge is turned up, the pot maker is ready to put on what is known as the "filling in" spell. This working is usually 12 inches in height and is worked with seven hand courses and five finger courses. The hand courses consist of working the clay on the pot with the ball of the hand with a downward motion. The pot maker is first supplied with rolls which are round pieces of clay about $2^1/_2$ inches in diameter by 4 inches long. This is

worked against the bevel side that has been turned up, and the side of the pot is held in shape by the left hand, the right hand working the clay, the object being to spread the clay in about one-fourth inches in thickness. (See figure 4.)

FIG. 4.—Working hand courses.

In putting on the hand courses, first one is put on the inside and the next on the outside; the next on the inside and so on until the seven hand courses are all on, after which the pot is beaten up, the working being wedge shape at this point.

Working Finger Courses.—The finger courses are next put on. This is the most difficult part of pot-making, and the pot maker who can not master the art of properly working the finger courses will never become an efficient pot maker. The working of the finger courses is just the reverse of the hand courses, which is a downward motion, while the working of the finger courses is an upward motion, and when the top of the stroke is reached with the right hand, the thumb on the left hand reaches over and breaks down the clay. (See figure 5.) The finger courses alternate, first on the inside and then on the outside, the same as in putting on the hand course.

After the pot has been filled in to a height of 12 inches, it is allowed to stand for several days until the clay has stiffened sufficiently to hold the second working, which consists of working about six inches of clay on top of the first spell with hand courses and finger courses the same as in filling in the pot. It is then allowed to stand for three or four days until the clay stiffens sufficiently to hold the next working.

FIG. 5.—Working finger courses.

Four workings of six inches each in addition to the filling in working, which is twelve inches high, are put on the pot at intervals of several days, allowing the pot sufficient time between each working to stiffen, which brings it to the proper height for turning the shoulder.

Shoulder Working.—The shoulder working is put on in the same manner, except in finishing it is turned in to take the form the crown is to be and allowed to stiffen for about a week to enable the sides to dry out sufficiently to support the heavy weight of the crown. (See figure 6.)

Beating Down Crown.—Various methods are used to crown in the pot. Some pot makers require two or three workings,

but the method followed by the writer is to use a little stiffer clay than has been used on the side of the pots, and to finish the crown in one working, by building the pot up to a foot or so higher than the pot will finish and then using a glass beater to beat it down

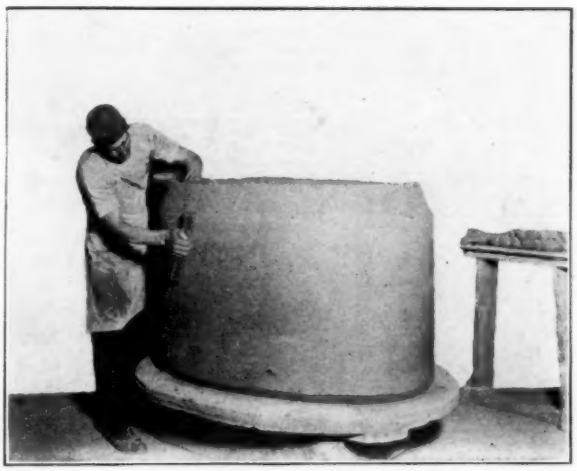


FIG. 6.—Shoulder working.

to the proper shape. No forms are used, as the air becoming compressed inside the pot will carry the weight of the crown. It looks easy, but requires considerable skill to properly beat down a crown without caving in the entire pot. (See figure 7.)

Finishing.—After the pot has been finished, the hood is put on, and the pot mouth is cut out. The inside of the crown must then be trimmed off to the proper thickness and carefully smoothed. The usual method employed is to trim the clay off with trimming irons fastened to the end of sticks about the length of broom handles. The writer employs a boy of small stature, one who can slip through the opening in the pot mouth, and once he is inside the work of trimming and smoothing the crown can be quickly and accurately done. The hood is then carefully smoothed down, and the pot allowed to remain on the board several weeks, when it is thrown off and allowed to rest on the front part of the

bottom and on the hood; this enables the bottom to dry. After the bottom has dried sufficiently, the pot is stored in a warm room to become thoroughly dry before it is shipped.

FIG. 7.—Beating down crown.

Pot After Fifty-one Weeks' Use.—Figure 8 shows a cross section of a pot after it had been in continuous operation for fifty-one weeks. If the condition of this pot was anything but what it is, one might say that it would be wrong for the wearing of the pot has been uniform as the thickness of the sides will show, and the interior does not show a pitted condition, but has worn down from the crown to the bottom.

Pot Used for Opal.—Figure 9 shows that I might term the ideal condition in which a pot should leave the furnace. The original thickness of the sides of this pot was four and one-half inches, and there were seven melts of flint glass and forty-three melts of opal made in this pot. It was worn so thin that it was impossible to take it from the furnace whole, and it broke into pieces. The sides of the pot and the bottom had worn to such an extent that in no place were they over two inches thick, and you will note that the pot was very smooth on the inside and free from

FIG. 8.—Pot after fifty-one weeks use.

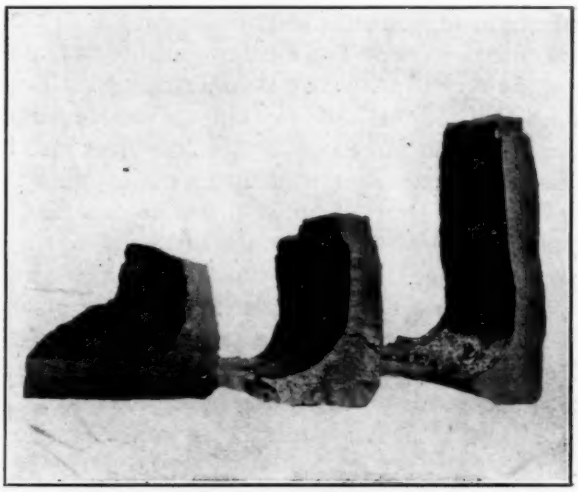


FIG. 9.—Pot used for opal glass.

holes. This pot was made from German clays. A later report from the same glass company, using the same opal batch and operating under the same conditions, gave a record of a pot made from all American clay of ninety-nine fillings of opal glass.

GILL CLAY POT CO.
MUNCIE, IND.

Discussion

MR. C. W. BERRY: Mr. Grafton's paper is a valued contribution to the subject of glass pot manufacture. It is especially interesting to learn that successful results have been secured with American clays, thus verifying the statements of other pot manufacturers and laboratories.

The question of ageing clays is one of considerable interest and tests have shown that even twelve weeks ageing is not necessary in order to obtain satisfactory results.

MR. C. W. CRUIKSHANK: In the European plate glass factories the open pots are built up in wooden molds. The mold is placed on a bottom board and the workman throws in lumps of prepared clay until there is sufficient quantity to make the bottom and part of the sides of the pot. The pot maker then handles the clay on the bottom, forcing it gradually up the sides of the wooden mold, pounding and driving out the air and making the bottom homogenous. There are two men to work alternately as the work is very hard. They keep pounding at the clay until it is brought about one-half way up the wooden mold, after which they throw in more clay against the sides with force and pound this into place. By this method a pot is finished in a day instead of building six pots up at the same time and finishing them up at the end of the week.

The pots are placed to dry in small rooms which hold about twenty pots, which are kept at a temperature of about 75° for two or three weeks, then the temperature is increased to 90° or 95°. The floors are heated by means of flues running under them which pass backwards and forwards under the floor. The heat is generated in a combustion furnace and after passing through the flues goes to the stack. Pots, if possible, are kept about nine months before being used.

NOTICE—*Further discussion of this subject is solicited. All communications should be sent to the Editor.*

A GLAZE STUDY INVOLVING SOME INTERESTING COLORS PRODUCED BY NICKEL OXIDE[1]

By J. D. Whitmer

The behavior of the different coloring oxides in various ceramic mixtures is always interesting and surprising results are frequently noted. Oxide of nickel is no exception in this respect. This study is the outcome of one of those accidental results which frequently come to the attention of the ceramist, and which make his work so fascinating.

In the transactions of our Society we find two references on the color effects produced by nickel oxide. In volume VI, page 195, Geijsbeck, in a discussion, states that the following colors had been obtained from oxide of nickel: Violet, blue, green, yellow, red and brown. In volume XIV, in an article entitled "Colors Produced by Nickel Oxide in Ceramic Mixtures Containing Zinc," Pence states he obtained blues and purples of varying hues.

In my own experience, I have noted colors to which no reference has been made, so far as I am aware, *viz.*, grays. It was with the object of investigating the influence of various RO combinations on the production of these colors that this study was undertaken.

Experimental

The materials used in this work include the following: Eureka feldspar, Golding cornwall stone, English cliffstone whiting, precipitated barium carbonate, red seal oxide of zinc, calcined magnesite, white lead, oxide of nickel, calcined North Carolina kaolin, Granville flint. All of these were taken from the regular factory stock excepting the calcined magnesite, which was purchased from the Roessler & Hasslacher Chemical Company expressly for this investigation. This was calculated as MgO. The oxide of nickel was a greenish colored powder obtained as a

[1] Received February 27, 1920.

result of calcining the blue oxide. It was considered as NiO for the purposes of this study.

The glaze chosen as the basis for this investigation was similar to the one used by Bryan in his study of the "Action of Chromium Oxide in Glazes Containing Zinc," volume X, of the Transactions of the A. C. S. Its molecular formula is:

$$\left.\begin{matrix} 0.25\ K_2O \\ .30\ CaO \\ .45\ BaO \end{matrix}\right\} \quad 0.35\ Al_2O_3\ 2.SiO_2$$

The K_2O in these glazes was supplied by both feldspar and Cornwall stone in equivalents of 0.15 of the former and 0.10 of the latter wherever the formula made this permissible. The reason for the use of stone rests on the fact that it reduces the amount of raw clay needed to satisfy the formula. In my experience this reduction of the clay addition has been found beneficial in overcoming the tendency of glazes to draw on the porous wall-tile bisque. Inasmuch as there was no opportunity to have chemical analysis of the various materials made, it was deemed sufficient for the purpose of this study to use the formulas and combining weights for the various materials given in the Manual of Ceramic Calculations, published by the Society.

The content of nickel oxide used was arbitrarily chosen at 0.025 equivalent and was made as a straight addition to the glaze. Lack of time prevented the investigation of larger additions of the coloring oxide, although a preliminary trial indicated some interesting possibilities along that line.

Four series of glazes were made to investigate the influence of the different RO oxides on the colors produced by nickel. The molecular formulas and batch weights of these glazes are given in table 1. In all series, the contents of Al_2O_3 at 0.35 equivalent and SiO_2 at 2.00 equivalent were maintained constant.

Series 1. In this series, consisting of six glazes, the K_2O and CaO were maintained constant at 0.25 and 0.30 equivalents respectively, while the BaO was replaced by ZnO in increments of 0.05 equivalent up to 0.25 ZnO. This, in a measure, overlaps the work reported by Pence, but is included here in order to make comparisons easy and also to check in a way the results he obtained.

Series 2. Again using the base glaze as a starting point, and maintaining the K_2O and CaO constant as in series 1, the BaO was replaced by MgO in increments of 0.05 equivalent up to 0.20 MgO. This affords a direct comparison of the action of zinc oxide and magnesium oxide.

Series 3. Glaze 5. series 1, whose RO content consists of 0.25 K_2O, 0.30 CaO, 0.25 BaO, 0.20 ZnO, was used as a basis for this series.

In the first two members, the K_2O, ZnO and BaO were maintained constant while MgO was increased at the expense of the CaO; in the third member, another increase of MgO was made at the expense of 0.05 BaO.

Series 4. Desiring to note the effect of PbO on such colors as might be produced in the above glazes, two glazes were made in which the K_2O was replaced by PbO. The starting point for this series was glaze 4, series 3, whose RO content is 0.25 K_2O, 0.20 CaO, 0.20 BaO, 0.20 ZnO, 0.15 MgO. In order to construct these glazes it was necessary to reduce the spar and stone. This was done by reducing the stone to 0.05 equivalent, and the spar from 0.15 to 0.10 equivalent.

Each glaze was weighed separately and ground in small ball mills. The glazes were then dipped on small wall tile ($1^1/_2$ by $1^1/_2$ inches) care being taken to get as uniform a coating as possible. The trials were then placed in a sagger containing cones and fired with coal in a commercial downdraft kiln. Cone 4 was down flat and cone 5 just started in this fire. This heat treatment as indicated by the trials was hardly sufficient to mature those glazes of series 1 highest in BaO and those of series 2 where MgO represents BaO. Nevertheless the results show very clearly the colors developed by the various RO oxides. If time had permitted, these trials would have been refired to a temperature which would have brought them to maturity.

Results

Series 1. The color changes developed with the replacement of BaO by ZnO checks Pence's results. The colors vary from a purplish brown in the low ZnO members to a bluish purple in

TABLE I

Series 1.—Common to all glazes 0.35 Al_2O_3, 2.00 SiO_2

Glaze No.	Formulas				Batch weights						
	K_2O	CaO	BaO	ZnO	Feldspar	Stone	Whiting	Barium carbonate	Oxide of zinc	Calcined clay	Oxide of nickel
1....	0.25	0.30	0.45	0.00	83.4	84.3	30	88.65	...	14.43	1.87
2....	.25	.30	.40	.05	83.4	84.3	30	78.8	4.05	14.43	1.87
3....	.25	.30	.35	.10	83.4	84.3	30	68.95	8.10	14.43	1.87
4....	.25	.30	.30	.15	83.4	84.3	30	59.10	12.15	14.43	1.87
5....	.25	.30	.25	.20	83.4	84.3	30	49.25	16.20	14.43	1.87
6....	.25	.30	.20	.25	83.4	84.3	30	39.40	20.25	14.43	1.87

Series 2.—Common to all glazes 0.35 Al_2O_3, 2.00 SiO_2

Glaze No.	Formulas				Batch weights						
	K_2O	CaO	BaO	MgO	Feldspar	Stone	Whiting	Barium carbonate	Calcined magnesite	Calcined clay	Oxide of nickel
1....	0.25	0.30	0.45	....	83.4	84.3	30	88.65	....	14.43	1.87
2....	.25	.30	.40	.05	83.4	84.3	30	78.80	2.02	14.43	1.87
3....	.25	.30	.35	.10	83.4	84.3	30	68.95	4.03	14.43	1.87
4....	.25	.30	.30	.15	83.4	84.3	30	59.10	6.05	14.43	1.87
5....	.25	.30	.25	.20	83.4	84.3	30	49.25	8.06	14.43	1.87

TABLE 1.—(*Continued*)

Series 3.—Common to all glazes 0.35 Al_2O_3 2.00 SiO_2

Glaze No.	Formulas					Batch weights							
	K_2O	CaO	BaO	ZnO	MgO	Feldspar	Stone	Whiting	Barium carbonate	Oxide of zinc	Calcined magnesite	Calcined clay	Oxide of nickel
1.....	0.25	0.30	0.25	0.20	....	83.4	84.3	30	49.25	16.20	....	14.43	1.87
2.....	.25	.25	.25	.20	0.05	83.4	84.3	30	49.25	16.20	2.02	14.43	1.87
3.....	.25	.20	.25	.20	.10	83.4	84.3	30	49.25	16.20	4.03	14.43	1.87
4.....	.25	.20	.20	.20	.15	83.4	84.3	30	39.40	16.20	6.05	14.43	1.87

Series 4.—Common to all glazes 0.35 Al_2O_3 2.00 SiO_2

Glaze No.	Formulas						Batch weights									
	K_2O	CaO	BaO	ZnO	MgO	PbO	Feldspar	Stone	Whiting	Barium carbonate	Oxide of zinc	Calcined magnesite	White lead	Calcined clay	Flint	Oxide of nickel
1....	0.25	0.20	0.20	0.20	0.15	....	83.4	84.3	20	39.4	16.2	6.05	....	14.43	...	1.87
2....	.20	.20	.20	.20	.15	0.05	83.4	42.15	20	39.4	16.2	6.05	12.9	29.41	22.20	1.87
3....	.15	.20	.20	.20	.15	.10	55.6	42.15	20	39.4	16.2	6.05	25.8	40.51	34.20	1.87

the higher Zn members. No strong blues were obtained, but Pence shows that this change comes with higher ZnO content than these glazes contain. His blues were obtained with from 0.30 to 0.40 ZnO.

Series 2. As before stated, this series is evidently immature, yet the action of MgO is easily discernible. From the purplish brown of glaze 1, a decided change to gray tones is distinguished with a small content of MgO. Those glazes higher in MgO become successively more gray until a neutral gray is reached with 0.15 and 0.20 equivalent. No particular difference in color is noted with increase of MgO from 0.15 to 0.20 equivalent.

Series 3. The strong fluxing action of the ZnO is evidenced here as all glazes are well matured. Glaze 1, corresponding to glaze 5, series 1, is a purple with bluish tone. Glaze 2 is a mingled purple and gray. Glaze 3 is a nice blue gray somewhat like the French gray. Glaze 4 is a gray of greenish hue. The bluish tint in this series can no doubt be traced to the influence of the ZnO, which is known to produce bluish tints.

Series 4. In this short series the action of PbO is observed. In both glazes the grays are of a decided yellowish tone due, no doubt, to influence of the PbO in producing browns.

Conclusions

In this study, we have demonstrated that grays are obtained from oxide of nickel in the presence of magnesium oxide. This is the point we are desirous of proving and in having done so we feel justified in presenting the results for your consideration.

NOTE.—On page 149, Vol. **14**, *Trans. Am. Chem. Soc.*, Pence notes that the familiar nickel brown color was obtained in a glaze of the following composition:

$$\left.\begin{matrix} 0.85\ PbO \\ .15\ K_2O \end{matrix}\right\} 0.20\ Al_2O_3 \left\{\begin{matrix} 2.0\ SiO_2 \\ 0.01\ NiO \end{matrix}\right.$$

In order to note the effect of larger amounts of oxide of nickel in a glaze of this type, the following experiment was made: Taking the above glaze as a base, nickel oxide was added to it in percentages of its batch weight, beginning with 1% and increasing 0.25% at a time up to and including 3%. The results were in-

teresting. With 1% oxide of nickel, the glaze was bright and of the familiar brown color, but with the next addition of oxide of nickel green flakes began to appear on the surface of the brown color. These green patches became larger and more numerous with increasing amounts of nickel until they completely covered the surface with a content of 3% nickel oxide, and we had a beautiful bright green semi-mat glaze. There seems to be no doubt that in this case the color is due to saturation of the glaze with nickel oxide.

AMERICAN ENCAUSTIC TILING CO.
ZANESVILLE, OHIO.

DISCUSSION

MR. R. H. MINTON: Everyone who has worked with mat glazes for tile, faience and terra cotta is familiar with the effect produced by either BaO or MgO upon colors which usually result in glazes with the RO composed of K_2O, CaO and ZnO. Glazes which the writer has used commercially check the results obtained by Mr. Whitmer. A glaze of the following composition shows the effect of BaO in producing a blue green with NiO:

0.20 BaO		
.15 K_2O		
.25 CaO	0.35 Al_2O_3	1.6 SiO_2
.30 ZnO		
.10 NiO		

Another glaze of a very similar composition, containing BaO and ZnO, but with an addition of SnO_2, will turn the color from a blue green to a grey green.

0.20 BaO		
.25 K_2O		
.14 CaO	0.25 Al_2O_3	2.0 SiO_2
.35 ZnO		.1 SnO_2
.06 NiO		

The introduction of MgO at the expense of ZnO always gives the greyish tinge as shown by the following glaze, which develops a pale greyish green.

0.30 K_2O		
.35 CaO		
.15 BaO	0.40 Al_2O_3	2.25 SiO_2
.10 MgO		
.10 NiO		

No doubt a higher content of MgO would produce a stronger shade of grey.

AUTHOR'S CLOSURE: The discussion by Mr. Minton is interesting and in a measure confirms the conclusions presented in my paper. It further serves to emphasize the necessity for a complete presentation of the conditions under which results are obtained.

In the glazes quoted by Minton, the content of nickel oxide is much higher than used in the glaze study under discussion. In all probability, this is the determining factor in producing the green colors which he reports. In none of the glazes quoted in my paper was there any color resembling green, although in a preliminary experiment on group 1, a content of NiO as high as 0.05 equivalent was used.

Calculating the batch weights for his glaze 1, we have the following: 39.4 barium carbonate, 83.4 feldspar, 25.0 whiting, 24.3 oxide of zinc, 7.5 oxide of nickel, 51.6 clay, 18.0 flint; total, 249.2. From these figures, we find that the nickel oxide content is equivalent to 3% of the batch weight of the glaze. This is interesting in light of the results reported in the note to my paper, wherein 3% of nickel oxide added to an ordinary bright raw lead glaze gave a bright green color. The influence which varying amounts of the coloring oxide may have upon the development of the grey color would form the basis for an interesting investigation.

Mr. Minton's statement that the effect of BaO is to produce a blue-green with NiO is rather surprising. As already stated, I surmise that the green color is due to the high content of nickel oxide and Pence has presented data[1] which seems to demonstrate that the blue from nickel oxide is due to the influence of ZnO. I have many times noted the blue-green color, varying in intensity with the NiO content in glazes with no BaO and high in ZnO.

[1] *Trans. Am. Chem. Soc.* **14**.

NOTICE—*Further discussion of this subject is solicited. All communications should be sent to the Editor.*

NOTE ON THE MOTION OF THE STIRRERS USED IN OPTICAL GLASS MANUFACTURE [1]

By E. D. Williamson and L. H. Adams

The fact that the molten glass has to be stirred constitutes one of the greatest differences between the processes of manufacture of ordinary kinds of glass (plate, bottle, window, and so forth), and optical glass. This stirring is necessary because of the much higher degree of approach to complete homogeneity needed in optical glass. As thorough a mixing as possible must be effected if first grade glass is to be obtained. Fenner[2] has given a full description of the practical details of the operation.

The stirrers used are necessarily of a very simple nature as the high temperatures of the melting furnaces preclude any possibility of gear arrangements inside the furnaces themselves. In general the stirring is done by means of a clay rod attached at right angles to a water-cooled metal pole which enters the furnace through a small opening above the level of the top of the pot of melted glass. Figure 1 shows a type frequently used.

In deciding on the type of motion to be used in driving the stirrer, and on the relations of the various parts of the mechanism to each other it is necessary to know the nature of the resultant motion of the stirrer itself, due to any given arrangement. This can often be done by constructing small models, but it is both valuable and instructive to have algebraic expressions for the final curves. Such equations often show the relations among the different variable quantities in a way that no models can. It is also difficult if not impossible to find from models the speed of the stirrer at any point; it is equally difficult to find its acceleration, on which depends the necessary driving force, at least to a large extent. These last quantities can readily be found algebraically.

The pots containing the glass are circular, and it is therefore necessary that the motions of the "business end" of the stirrer

[1] Received February 27, 1920.

[2] Fenner, C. N., This Journal, 2, 125, 1919.

be roughly circular. In order to secure good mixing it would appear natural to suppose, however, that absolutely uniform circular motion of the stirrer would not be most efficient, as it would tend, at least when the melt is exceedingly liquid, to set up a rotation of the whole contents, a state not so conducive to mixing as a more turbulent motion would be.

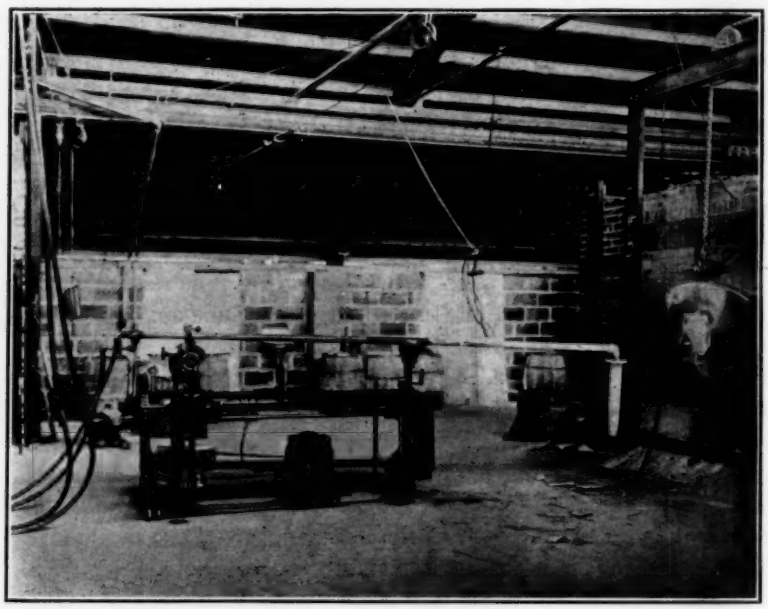


FIG. 1.—One type of stirring machine used in the production of optical glass.

In the following pages we discuss, for two simple cases, the shape of the curve traced by the business end of the stirrer, the variation in the velocity of the stirrer at different parts of the curve, and the area of the curve traced in relation to the surface area of the glass in the pot.

Case 1. (See figure 2.) The cold end B of the stirrer pole BD moves around a circle BB'. At C, a fixed point, the pole moves over a pulley or other arrangement. A is the center of the circle and the arm AB is driven around by a motor and gears at a uniform speed. The motion of D is to be discussed.

If θ be the angle between the pole BD and the fixed line AC, the position of D is fixed by the variable length CD and the angle θ. Let r denote the radius of the circle, c the length AC, l the

FIG. 2.—B represents the butt end of the pole and is constrained to move in a circle with center A. C marks the position of the pulley over which the pole slips. D is where the stirring rod is attacted and is the point whose motion is under discussion.

length of the pole and R the variable length CD. Elementary trigonometry shows

$$R = l - c\cos\theta \pm \sqrt{r^2 - c^2\sin^2\theta}$$

The double sign is due to the fact that to each angle there correspond two positions of D according as B is on the side of the circle next C or remote from C. If polar coördinate paper is available, the value of R may be used directly to plot the curve resulting from given values of r, c and l. Otherwise let C be the origin and the extension of AC the X axis and it follows that the curve is given by

$$x = \cos\theta\left\{l - c\cos\theta \pm \sqrt{r^2 - c^2\sin^2\theta}\right\}$$
$$y = \sin\theta\left\{l - c\cos\theta \pm \sqrt{r^2 - c^2\sin^2\theta}\right\}$$

In these expressions the values are taken for values of θ from $\theta = 0$ to $\theta = \sin^{-1} r/d$ and either both $+$ signs or both $-$ signs are used. It is much more convenient to use this form than the somewhat complicated relation between x and y got by the elimination of θ.

Figure 3 shows the curves drawn for various values of the constant involved. From these it is at once obvious that except when c is about equal to $l/2$ the curve is not in the least circular. The broken circle around the middle curve is the circle which just touches it at three points. Its radius is 1.059 times the radius of the circle in which the other end of the stirrer moves. The area covered by this circle is about 10 per cent more than the

area of the figure. The mathematical details of the computations are omitted, as they serve no useful purpose here.

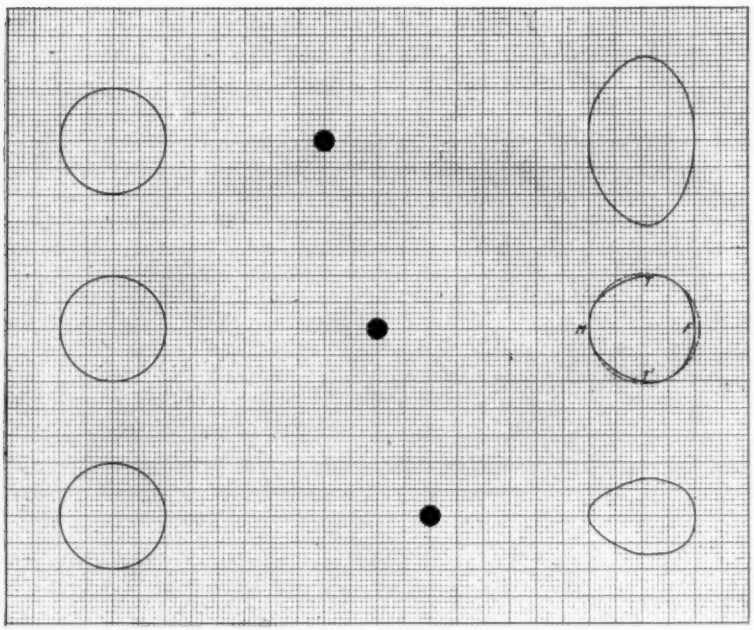


Fig. 3.—The black dots represent the position of the pulley (C in Fig. 2) and the curves at the right hand represent the curves traced by the stirrer (D in Fig. 2) for different positions of the pulley.

As the butt of the stirrer-pole moves round its circle with uniform speed V, the stirring rod moves with variable speed, the formula being rather involved. In the case $l = 10$, $c = 5$, $r = 1$, the maximum speed is $3/2\ V$ at F and the minimum is $2/3\ V$ at H, while at T and T' the speed is equal to V. In general there are two places (given by $\sin\theta = r/d$) where the speed equals V while the speeds at the points F and H are $\frac{l - c + r}{c - r} V$ and $\frac{l - c - r}{c + r} V$, respectively.

Case 2. A second arrangement which may be used is shown in figure 4. This case differs from the previous one in the motion at C. At that point a pin is fixed to the stirrer pole and this pin

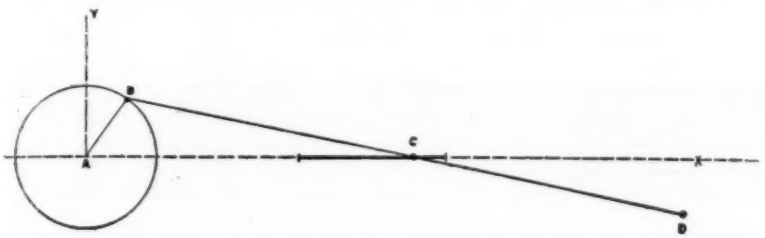


FIG. 4.—B represents the butt end of the stirrer as before. C is a pin fixed in the pole but sliding in a slot along the axis as marked by the heavy line. The motion of D is discussed.

moves in a slot along the line AX. In this case if x and y be the coördinates of D parallel to AX and AY, θ the angle BAC, r the radius of the circle, l_1 the length BC and l_2 the length CD

$$x = r\cos\theta + (l_1 + l_2)\sqrt{1 - \frac{r^2\sin^2\theta}{l_1^2}}$$

$$y = \frac{r\,l_2\sin\theta}{l_1}$$

It is more convenient to use this form for calculation than to eliminate θ (although the elimination is simple) as that leads to an equation of the fourth degree.

Figure 5 shows the form of curves obtained when $r = 1$ and l_1 and l_2 are 4 and 6, 5 and 5, 6 and 4, respectively, in the three cases.

Except when l_1 is about equal to l_2, the motion is far from circular. Round the curve for $l_1 = l_2$ the circle is drawn which touches the curve at three points. This curve has a radius = 1.052. For this type of motion the areas of the curves described are easily evaluated, as they are obtained by multiplying the area of the circle, in which the butt moves, by l_2/l_1. In the case where $l_1 = l_2$, the area of the curve therefore equals the area of the circle and is about 10 per cent less in area than a circle of radius 1.052.

The speed of the motion is more uniform in this case than in the previous one. There are as before two places where the speed is equal to that in the circle, namely, the points where

$\cos \theta = 0$, *i. e.*, the points where the radius arm is at right angles to the line of centers. When $l_1 = l_2$ there are two other points of equal speed, namely, where $\sin \theta = 0$ or the points where the radius arm coincides with the line of centers; in general the speed at these points $= l_2/l_1 \times$ speed in circle.

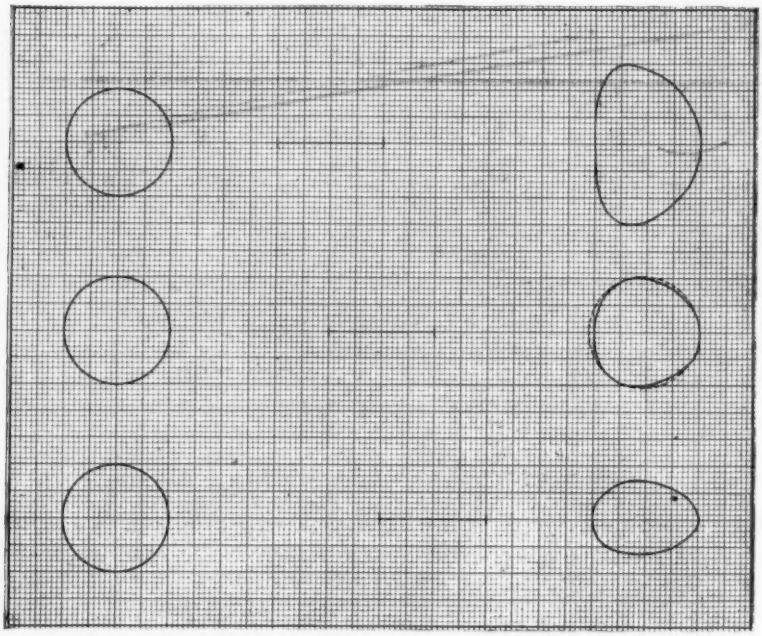


FIG. 5.—The heavy lines represent the slot in which *C* (fig. 4) moves. The curves at the right hand represent the curves traced by the stirrer (*D* in fig. 4) for different positions of the pin (*C*) in the pole.

It would seem that the last arrangement, with $l_1 = l_2$, gives the most satisfactory results compatible with such simplicity of design. If a true circular motion of the business end were needed it would be a simple matter to have a cam made on the model of one of the curves and to cause the cold end to describe that figure instead of a circle. (The analysis of the problem would then be reversed and the business end would describe the circle.) This could be carried out with equal ease, using either type of arrange-

ment. It could also be carried out with different length ratios and this might be convenient for reasons connected with available space and the distance into the furnace which must be reached.

Fenner in the paper cited stated that the maximum convenient radius of the butt circle was seven inches when pots were being used whose inside radius was certainly more than twelve and a half inches. In view of the discussion just given, even allowing an ample figure for the thickness of the stirrer, there should have been no danger of hitting the pot wall using at least a nine inch circle. At the same time he calculated the speed of the motion of the butt round its circle and took that as the speed of the stirrer through the glass. The formula developed from the path equation given in this paper suggests that the maximum speed was about one-fifth greater than this, while the minimum was correspondingly less.

GEOPHYSICAL LABORATORY,
CARNEGIE INSTITUTION OF WASHINGTON,
February 1920

NOTICE—*Further discussion of this subject is solicited. All communications should be sent to the Editor.*

CERAMIC ABSTRACTS

General

The commercial application of electrical osmosis. J. S. HIGHFIELD, W. R. ORMANDY AND NORTHALL. *Pottery Gaz.*, **45**, 775–777 (1920).—The addition of a small amt. of alk. to a suspension of clay in water results in the suspension of clay particles in water while pyrites, mica, free silica and other impurities settle to the bottom. Fine particles which do not settle may be removed by the osmotic process. Bodies which remain in suspension and tend to move toward the cathode, require an electrolyte of an acid character to bring about dispersion or peptization, but bodies which tend to move to the anode require an alk. electrolyte to cause dispersion. Osmosed fireclays are entirely free from pyrites and goods made therefrom are not subject to green stains when glazed. By the use of fine osmosed kaolin, chem. porcelain has been produced of the highest quality, the body being made of pure kaolin, which, owing to the fineness of the particles, completely vitrifies. There is also a better locking of the glaze to the body by fine sillimanite crystals, which form on firing and penetrate the glaze. In clays themselves, the extremely fine particles could be separated from the coarser. Another application is in the electro-osmotic filter press. The press consists of a series of chambers into which the suspension is fed under a head of 10 feet, sufficient to ensure a rapid filling of the chambers. The chambers are closed on both sides by filter cloths in the ordinary way, but the cloths are held in position by perforated or grooved metal, carbon or other conducting plates, one of these plates forming the cathode and the other the anode. An electric pressure of 20 to 100 volts, depending upon the substance, is necessary. In this press very fine material which would clog up the ordinary filter press, can be dewatered. H. Jackson stated that in using a well-known clay for a muffle he was only able to get 24 hours' service from the same. By treating this clay by osmosis he made muffles from which he got 10–15 times the service. Ormandy stated that a muffle made of osmosed clay lasted 13 journeys whereas the muffles made of the same clay, not treated, would never last more than 3 journeys. With the finest English china clay which had been treated with 87 tons of water in order to wash 3 tons of clay, it was still possible to separate 7 per cent material from the clay. H. G. SCHURECHT.

An efficient oil burner. W. J. JONES. *Pottery Gaz.*, **45**, 767 (1920).—A high pressure oil burner adapted for cheap fuel consisting of 50 per cent creosote and 50 per cent pitch is described. The fuel is kept in storage tanks where it is kept heated to 100° F. by means of steam coils. The storage tanks are about 10 feet above the burner and an air pressure of 60 lbs. is used.

The oil is introduced by means of a drip feed. An accumulator was resorted to in order to pass air through the burner, thus atomizing the oil. An annulus is on the front of the burner into which air is admitted at the same pressure. Around the face of the burner are serrations through which the air is passed in a solid ring, so as to prevent the atomized oil from spreading too quickly. With this burner a narrow stream of atomized oil and high pressure air pass well into the furnace. The results were so efficient that with a single burner of this type a furnace 15 × 8 feet, containing eight glass pots, could be kept at a constant flame temp. of 1500° C. The oil consumed was about 16.8 gals. per hr. More complete combustion can be obtained by oil firing than with lump coal. H. G. SCHURECHT.

PATENTS

Dryer. WARREN B. HUTCHINSON. U. S. 1,338,731, May 4, 1920. A rotary imperforated dryer having a screw feed for material therein, the screw being perforate for the passage of air, and means of forcing a drying medium through the screw and dryer in the opposite direction to the feed of the screw.

Process for drying materials. HUGH B. LOWDEN. U. S. 1,339,771, May 11, 1920. A method of mechanically drying materials consisting in delivering the material upon hearth at one end, and advancing the material over the hearth toward the other end by repeatedly cleaving it in a substantially vertical direction and pushing it through a small part of the length of the hearth.

Method for molding plastic materials. DIRK SHANSTRA. U. S. 1,340,452, May 18, 1920. A process of making balls from plastic material which consists in first bringing the material to an elongated ball shape on one mold and then finishing it to its spherical shape in another mold by pressure longitudinally of its major axis.

Drying kiln. CLIFFORD A. CUTLER. U. S. 1,341,884, June 1, 1920. A kiln having walls, a ceiling and false ceiling, a plurality of supports arranged above the floor, air intake in the ceiling, the false ceiling being formed, with air opening, means for regulating the openings in the false ceiling, means for providing a plurality of air blasts arranged in the space between the floor and the supports, and air exhaust duct opening near the bottom of the kiln.

Air-conditioning apparatus for drying-kilns. HERVEY N. ANDREWS. U. S. 1,343,894, June 22, 1920. In a drying kiln, means for adding to the humidity of the air, means for taking moisture from the air, and synchronized means including a control element governed by the degree of humidity in the air for controlling both of the means.

Drying plant. PRLADE BARDUCCI. U. S. 1,344,163, June 22, 1920. Apparatus for drying materials in a drying room, comprising a plurality of supports arranged longitudinally in the room, a ventilating device embodying

a casing having mouths in its walls facing the supports and ventilating means located in the casing and means for reciprocating the casing in the room along the supports, the ventilating means producing simultaneously draft air streams and blast air streams between the supports.

Drying apparatus. SIJTSE HERO MEIHUIZEN. U. S. 1,344,241, June 24, 1920. The apparatus comprises an open ended drying chamber, means for heating and simultaneously creating a draft through the chamber, a frame movable vertically within the drying chamber, trays carried by the frame, and receptacles supported by certain of the trays, the trays being arranged to direct the draft within the drying-chamber to the top of the receptacles.

C. M. SAEGER.

Whiteware and Porcelain

Some pitfalls in body making. A. HEATH. *Pottery Gaz.*, **45**, 782–783 (1920).—In selecting a ball clay the usual method is to mold a test piece and measure the contraction upon drying and after it has been fired. If the contraction is normal and the color as good as that of the clay being used the potter feels justified to use it. These tests are not sufficient. For example, ball clays vary in moisture content from 8–18 per cent which would have a bearing upon its value. Others contain carbon varying from 8–9 per cent. Again some clays contain considerable sand. The correct way to test a ball clay is to test it for fineness by passing it through a fine screen, ignite it to determine its carbon content and analyze it to determine its chemical compn. Stone varies considerably in alks., the hard purple type contains 8 per cent, while the buff contains about 3.5 per cent. The substitution of buff stone for the purple stone has caused considerable trouble. Flint is also a source of trouble, there being two varieties, boulder and chalky flint. By the introduction of lime into the body with chalky flint, crazing may occur. Greater accuracy in mixing is emphasized and weighing should be done to $^1/_2$ oz. Owing to the expansion of flint upon calcination an excess would cause peeling. The use of measuring is inaccurate, since a variation of $^1/_8$ inch may make a difference of $2^1/_2$ per cent. For judging the fineness screens alone are not sufficiently accurate. Where Na_2SiO_3 is used in casting the ap., fr. should be measured from time to time as this often varies. In making bone china one of the common faults is green china caused by an excess of clay. Since the range of compn. for good bone china body is often small, this trouble may be often traced to the fact that the clay in storage has dried considerably and consequently too much is added to the body.

H. G. SCHURECHT.

Recent achievements in pottery casting. BY A MEMBER OF STAFF. *Pottery Gaz.*, **45**, 773–774 (1920).—Seven or eight yrs. ago A. Leonhardi of Schwepnitz, Saxony, used the casting process in connection with the manuf. of large glass pots. Dr. Weber also obtained a patent on an electrolytic process for casting glass pots, 28 inches deep and 24 inches in diameter,

which were cast in a mold constructed of plaster and iron. The time occupied for casting by this method was only 1 or 2 minutes. Until recently, however, British glass pot makers have looked askance at the casting process. Later B. J. Allen, of Stoke-on-Trent, developed a process of casting by vacuum and pressure, which promises to revolutionize the present system of hand manufacture. By the casting process it is possible to produce a glass pot of 36 inches in diameter in as many days as it now takes months by the hand-building process. On May 27, 1919, the first fireclay gas retort ever produced in England was exhibited. It had a diameter of 2 feet, 4 inches, a thickness of 2 inches and a length of 5 feet. A two-piece plaster mold with a core was used. The molds which are about 3 inches thick, are reinforced by a casing of wood. The two parts when fitted together are held in place by an outer frame of wood bound with iron hoops. The mold is filled with a slip by means of funnels. After casting the ware is left 18 hours, after which the core is removed and the outer molds are taken off.

H. G. SCHURECHT.

Glass

The development of various types of glass. Part I. The interaction of silica with the oxides of sodium and potassium. Part II. The interaction of silica, lime and sodium oxide. Part III. The interaction of silica, lime and potassium oxide. Part IV. The interaction of silica, lime and the oxides of sodium and potassium. Part V. A comparison of the soda-lime-silica and the potash-lime-silica glasses. C. J. PEDDLE. *J. Soc. Glass Technology* **4**, 3–107 (1920).—The data summarized in these excellent papers are the result chiefly of researches by the author during the past four years in connection with the production of optical glass. A great mass of data is presented. *Conclusions regarding soda-silica glasses.* Experiments with glasses containing 17 to 50 per cent soda showed: (1) with over 75 per cent silica and under 25 per cent soda required temperatures above 1300° C for their production; (2) glasses with less than 70 per cent silica and more than 30 per cent soda all melted down below 900° C; (3) glasses with over 28 per cent soda were totally insoluble in H_2O, indicating that no free silica molecules were present; (4) increasing soda increased pot attack; (5) glasses with 28 to 40 per cent soda did not devitrify. Below 28 per cent soda, the silica tended to separate out, and above 40 per cent soda the crystallization of sodium silicates took place readily; (6) glasses with over 20 per cent soda weathered rapidly; (7) density increased with increase in soda, but above 40 per cent the changes were small. The density of silica was found to be 2.220 and of soda (Na_2O), 2.625; (8) the refractive index increased with increase in soda, but the rate of increase fell more rapidly than in the case of density; (9) none of the soda-silica glasses would be of use for optical work. Low durability rules out all above 17 per cent soda and the low soda glasses easily become devitrified. *Conclusions regarding potash-silica glasses.* Experiments with 24 to 61 per cent potassa (K_2O) showed: (1) Such glasses

are difficult to produce and can not be preserved except in a dry atmosphere, free from CO_2; (2) durability decreased and solubility increased with increase in potassa; (3) glasses with over 30 per cent potassa were totally soluble in water; (4) compared with equivalent soda glass it was noted that the potash glasses (*a*) were easier to melt; (*b*) showed less color, (*c*) were less durable, and (*d*) between 20 and 40 molecules per 100 of silica the potash glasses gave a higher index of refraction and greater total dispersion. This may be true for the whole series but the data were not obtained. *Conclusions regarding soda-potash glasses.* Experiments with glasses containing both soda and potash showed that properties were intermediate between those of soda and of potash glasses. *Conclusions regarding soda-lime-silica glasses.* Experiments were made with two series with molecular ratios of 100 SiO_2, 40 Na_2O, x CaO and 100 SiO_2, 20 Na_2O, x CaO. The results showed: (1) All glasses of both series could be melted at temperatures above 1300° and all showed attack on the pot; (2) increase in either lime or soda increased pot attack, the soda being more corrosive than the lime; (3) because of volatilization and pot attack large melts show higher index of refraction than small melts; (4) density increased with additions of either lime or soda, the lime showing greater increases per molecule added; (5) density increases per molecule of lime added were not constant. The increase was greatest with low soda and the effect lessened as the lime content increased. The lessening effect of increasing lime was greatest with high soda glasses; (6) refractive index increased with increases in lime or soda, more with lime than with soda, the rate of increase falling with high lime content. With high soda this fall in rate is greater than with low soda glasses; (7) where molecular lime-silica ratio was the same, the glass with the higher soda content had the higher index and the higher total dispersion; (8) total dispersion increased with increases in lime or soda; (9) the dispersive reciprocal decreased continually as the index for the D line increased; (10) increasing lime or soda lengthened both ends of the spectrum, the blue more than the red, and the lengthening effect of lime was greater in the series with the lesser soda; (11) with over 72 per cent SiO_2 there is a tendency to vitrify; (12) glass of this type with over 10 per cent lime divitrifies easily if the soda is over 20 per cent. With soda under 15 per cent, the lime may be increased up to 15 per cent before showing devitrification; (12) solubility in water increased with increases in soda and decreased with increases in silica or lime; (13) durability is therefore increased by adding lime or silica and lowered by adding soda; (14) all glasses with over 15 per cent soda became dim on long exposure to air; (15) none of these straight soda-lime glasses is suitable for first-class optical work. They either are not durable or they divitrify too easily; (16) for jars, bottles, etc., a glass containing about 100 SiO_2, 20 Na_2O, 20 CaO, is useful. Lime even up to 14 per cent is satisfactory. The modern tendency is to use too little lime; (17) glasses with over 16 per cent soda are not durable enough to warrant their use for food containers; (18) if soda is not above 15 per cent and silica is about 72 per cent there is practically no tendency to divitrify; (19) probably

the best batch of this type is sand, 720; soda ash, 260; limestone, 230 parts. If salt cake is used, substitute 350 parts for the 260 of soda ash and add charcoal or powdered coal, 1 part to every 20 of salt cake. *Potash-lime-silica glasses.* Series similar to the soda-lime-silica glasses were studied. The first series was based on 100 SiO_2, 40 K_2O, x CaO and the second series on 100 SiO_2, 20 K_2O, x CaO. Conclusions: (1) All of the glasses can be melted above 1300° C; (2) all attacked pot clay; (3) density and index of refraction both increased with additions of lime or potassa (K_2O), lime having the greater effect per molecule added; (4) total dispersion increased with additions of lime or potassa, the rate of increase being greater with the lower potassa content; (5) dispersive reciprocal was higher in the series with lower potassa and decreased with increasing lime or potassa; (6) with potassa above 34 per cent devitrification took place readily; (7) solubility decreased with increase in lime or silica but increased rapidly with increases in potassa; (7) none of the glasses are good optical glasses. *Soda-potash-lime-silica glasses.* Two series of glasses were made, 100 SiO_2, 20 Na_2O, 20 K_2O, x CaO and 100 SiO_2, 10 Na_2O, 10 K_2O, x CaO. Conclusions: (1) Density and refractive index increased with increase in lime or alkali, the effect of lime being greater per molecule added; (2) dispersive reciprocal was higher in the series with the lower alkali and decreased as lime or alkali increased; (3) in the first series glasses with over 9 per cent lime were easily devitrified; (4) in the second series lime could be increased to 13 per cent without devitrification; (5) solubility in water decreased with increases in lime but increased rapidly with increases in alkali; (6) none of the glasses shows first-class durability but glasses about 100 SiO_2, 10 Na_2O, 10 K_2O, 20 CaO, might be used in optical instruments, especially if protected. The index for D line is about 1.25, and dispersive reciprocal about 59.4. The durability is about like Schott silicate crown No. 0.337. *Comparison of the above types.* The comparisons apply to glasses of the molecular type 100 SiO_2, y R_2O, x CaO, where R_2O may be Na_2O or K_2O or equimolecular Na_2O-K_2O mixtures, y varying between 20 and 40 molecules and x between 5 and 40 molecules. All comparisons are based on molecular ratios. Conclusions: (1) Density, refractive index and total dispersion is higher in the soda than in corresponding potassa glasses; (2) the soda glasses have the lower melting points; (3) devitrification was more easily induced in the soda than in the potassa glasses; (4) with high lime glasses increase in silica tended to prevent devitrification; (5) glasses which tended to deposit silica were improved by adding lime; durability of the soda glasses was better than that of the potassa glasses (from the standpoint of percentage weights the reverse is true); (6) no glass of the type 100 SiO_2, 40 R_2O, x CaO is of practical use, all being too soluble; (7) glasses of about 100 SiO_2, 20 R_2O, 20 CaO are of value—all other glasses in the series are of little or no value on account of devitrification or failure in weathering; (8) this typical formula (which may be written 5 SiO_2, 1 R_2O, 1 CaO), is believed to be better for lime-alkali-silica glasses than the Benrath formula, 6 SiO_2, 1 R_2O, 1 CaO so commonly used. C. H. KERR.

A suggested improvement in the manufacture of glasshouse pots. C. W. THOMAS. *J. Soc. Glass Technology* **4**, 107–111 (1920).—Covered pots might be made in two sections, top and bottom, and to obviate the possibility of an open joint, a cushion of asbestos rope may be fitted at the joint, each part being grooved to hold the rope. The author suggested this because of the success of a similar experiment at nearly as high a temperature in another industry. There the rope lasted seven years. The chief advantage of the two-section pot is in permitting tamping the interior surface to make it denser and tougher. C. H. KERR.

The optical properties of some lime-soda glasses. J. R. CLARKE AND W. E. S. TURNER. *J. Soc. Glass Technology* **4**, 111–5 (1920).—The series of glasses investigated ranged from 2 Na_2O, 6 SiO_2 to Na_2O, CaO, 6 SiO_2. Conclusions: (1) The refractive index for the D line is practically an additive property of the composition; (2) replacing each 0.1 molecule of soda by 0.1 molecule of lime increased the refractive index, on the average, by 0.0020; (3) there is very little change in total or partial dispersions or in dispersive reciprocal throughout the series; (4) the ultraviolet absorption band is fairly constant at about wave length 0.295 microns. The glasses are very transparent to ultraviolet light. C. H. KERR.

The thermal expansion of magnesia-containing glasses. S. ENGLISH AND W. E. S. TURNER. *J. Soc. Glass Technology*, **4**, 115–20 (1920).—Expansions were determined for a temperature range of 25–90° C. The glasses ranged from 0 to 9 per cent magnesia, from 24 to 12 per cent soda and from 74 to 78 per cent silica. Coefficient of expansion is an additive property of the composition. Replacing soda by magnesia causes rapid lowering of expansion. Magnesia is much more effective than lime in reducing expansion, but is not as abnormal in this respect as claimed by Schott. New factors, superior to the Schott factors, are given.

	Schott factors	English and Turner
SiO_2	0.8	0.05×3
Na_2O	10.0	4.32×3
CaO	5.0	1.63×3
MgO	0.1	0.45×3

The Schott factors are for cubical expansion. The English and Turner factors are for linear expansion and therefore must be multiplied by 3 for comparison with the Schott figures. C. H. KERR.

The comparative effects of soda and potash in lead glass for table ware. F. W. HODKIN AND W. E. S. TURNER. *J. Soc. Glass Technology*, **4**, 120–5 (1920).—Three series of glasses were studied.

	Series I			Series II			Series III		
	1	2	3	A	B	C	D	E	F
Sand	504	504	504	500	500	500	500	500	500
Red Lead	224	224	330	330	330	330	330	330	330
Borax	10	10	10	...	...	...	10	10	10
Soda ash (95%)	144	72	...	134	66	...	134	67	...
Sodium nitrate	42	21	...	21	10	...	20	10	...
Potash	...	94	188	...	83	165	...	83	165
Potassium nitrate	...	25	50	...	13	25	...	13	25

Conclusions: (1) The lead-soda glasses melt most readily and the lead-potash least readily; (2) the lead-soda-potash glasses, with equivalent proportions of soda and potash, fine more readily than either of the others; (3) the lead-potash glasses are the most viscous and the lead-soda the least; (4) color due to pot corrosion is worst with soda glasses and best with lead-potash; (5) the presence of about 2 parts of borax per 100 of sand makes lead glasses notably more durable; (6) a mixture of alkalies is preferable for all round purposes, and mixed alkali glasses are more durable than with either alkali alone. C. H. KERR.

The density of soda-lime glasses. S. ENGLISH AND W. E. S. TURNER. *J. Soc. Glass Technology*, **4**, 126–8 (1920).—Results as indicated in the table show that substituting lime for soda increases density. The Winkelman and Schott density factors used in calculating density are obviously too low and

Glass No.	CaO Per cent	Density observed at 20° C	Density calculated W. & S. factors
1	...	2.4353	2.383
2	1.57	.4384	3.383
3	2.63	.4416	2.389
4	3.79	.4462	.391
5	4.54	.4507	.401
6	6.22	.4602	.419
7	7.56	.4650	.418
8	8.15	.4682	.413
9	9.26	.4757	.419
10	10.40	.4850	.429
11	11.63	.4904	.431
16	18.06	.5866	.523
17	17.35	.5547	.490

require revision. C. H. KERR.

The preservation of glass furnace refractories by water-cooling. E. B. CHRISTMAS. *J. Soc. Glass Technology*, **4**, 128–38 (1920).—The Knox system is described. C. H. KERR.

PATENTS

Cutting-off device for glass-drawing apparatus. WILLIAM E. STANDLEY. U. S. 1,338,109, April 27, 1920. A cooling and cutting-off device for glass cylinders, comprising an annular casting provided in its body with an annular gas conduit and a passage to receive a cooling medium to cool the glass that attaches to a drawing bait, the gas conduit being arranged to be attached to a gas supply and having a plurality of outlets for directing a series of gas jets against the periphery of the glass cylinder.

Apparatus for delivering mold charges from glass-furnaces. SCOTT DAVIDSON AND ALEXANDER L. SCHRAM. U. S. 1,338,214, April 27, 1920. The apparatus provided with a discharge orifice, through which molten glass may flow by the action of gravity, an imperforate plunger projecting into the furnace and adapted to completely close the upper end of the orifice, the peripheral portion of the lower face of the plunger, being flat and adapted to form a close joint with the upper end of the wall surrounding the discharge orifice, the plunger adapted on its downward stroke to assist the action of gravity in the flow of glass through the orifice, and on its upper stroke to retard the flow.

Process and apparatus for the production of sheet-glass. GEORGE B. STANTON. U. S. 1,338,261, April 27, 1920. The process consists in pouring the molten glass in a sheet of uniform thickness, moving a collecting medium downwardly past the point at which the glass is poured, whereby to collect by adherence to the said medium the first poured portion only of the sheet, and as the sheet is formed through hardening of the glass leading the sheet downwardly by the collecting medium, and subsequently disassociating the collecting medium from the sheet; also a container for molten glass arranged at one side to discharge the glass in a sheet of uniform thickness by pouring, means for adjusting the container to pour the molten glass therefrom, bait rods, and means for supporting and moving the bait rods downwardly past and in close proximity to the pouring side of the container.

Glass shaping or blowing machine. ARTHUR WILZIN. U. S. 1,338,604, April 27, 1920. In a suction head for glass blowing and molding machines, the combination with a neck mold, of a movable plunger adapted to cooperate therewith, a spring adapted to normally hold the plunger out of coöperative relation with the neck mold, a parison mold also adapted to coöperate with the neck mold, a pneumatic piston for moving the plunger into coöperative relation with the neck mold, the piston being actuated against the tension of a spring by the suction existing in the parison mold only during the latter part of the filling thereof, and means for adjusting the tension of the spring to determine the stage in the filling operation at which the plunger is moved into coöperative relation with the neck mold.

Method of and apparatus for manufacturing glassware. ERICK P. LINDAHL. U. S. 1,338,941, May 4, 1920. The combination of a carrier, blank supports

thereon, scoring means for the outer end of the blanks, supported by the blank supports, also heating means for the outer ends, and also chilling means for the outer ends, the heating means and chilling means positioned with relation to a carrier to cause coaction between outer ends and scoring means.

Drawing glass sheets. HARRY G. SLINGLUFF. U. S. 1,339,229, May 4, 1920. A tank adapted to contain a body of molten glass, with a means at each side thereof for maintaining the position of the edge of a sheet of glass being drawn comprising a body of refractory material lying beneath the surface of the glass and provided on its upper side with a groove whose inner portion constitutes the locus of generation of the edge of sheet, and a chilling bar extending between said means.

Glass drawing and cutting mechanism. IRVING W. COLBURN. U. S. 1,340,262, May 25, 1920. Drawing a sheet of plastic glass, bending it and feeding it in a horizontal plane until it is cooled to a frangible state also with a mechanism for scoring a sheet of glass of coöperating means for fracturing the sheet along the scored line.

Sand grading apparatus for glass grinding machinery. JOHN WILLIS. U. S. 1,342,038, June 1, 1920. The apparatus comprises a primary grader adapted to receive water and abrasive, a secondary grader consisting of a series of successively arranged partitioned compartments, a means for supplying sand and water from primary grader to the first compartment of the secondary grader, including means to remove water and sand from compartments.

Removing of glass from furnaces. ENOCH T. FERNGREN. U. S. 1,342,042, June 1, 1920. The method consists in creating a directionally predetermined and constant flow of refined glass of homogeneous fluidity, maintaining the constancy of the fluidity in the glass and taking successive gathers from untouched portions to the surface of flowing glass.

Pressing-plunger mechanism for glass machine. WILLIAM J. MILLER. U. S. 1,342,056, June 1, 1920. The mechanism comprises a reciprocating member, a yoke mounted on the member and capable of rocking in relation thereto, grasping fingers pivotally attached to the yoke and depending below the member, resilient means for spreading said fingers apart, a pressing plunger impinging against the under surface of the member, also with a means for locking said fingers into engagement with sand pressing plunger.

Glass-shaving apparatus. JAMES H. ALLAN. U. S. 1,342,080, June 1, 1920. The apparatus comprises a buoyant ring member and a top stone above the ring member and contracting therewith, the superposed contacting faces of the top stone and ring member being provided with annular interengaging portions capable of retaining glass seal separated from the bath of molten glass, the contiguous faces being flared from the interengaging portions to the peripheries to permit the access of sufficient heat to the glass seal to maintain the glass in molten condition.

Glass annealing furnace. MAURICE A. SMITH. U. S. 1,342,233, June 1, 1920. A furnace with an annealing chamber inclosed with flues formed in sides and top around chamber with a series of checker-work chambers at the bottom of the furnace communicating with the flues, including opening for delivering air and gas to the checker-work chambers and a stack with which flue communicates.

Reinforced glass and process of making the same. AEON FRANCOIS MASCART. U. S. 1,342,267, June 1, 1920. The process of making non-scatterable glass which comprises applying to a sheet of glass successively a solution of gelatin and a solution of cellulose material, at least one of the solutions containing a solvent which has a solvent action upon both the gelatin and the cellulose material.

Laminated glass. MARSHALL W. GLEASON. U. S. 1,342,282, June 1, 1920. Glassware comprising a plurality of laminae one of which is a distinctive color, while the others are of a neutral character as to color, but different from each other.

Blown glass vacuum brick. ALFRED E. D'HARLINGUE. U. S. 1,342,404, June 1, 1920. A blown glass brick of rectangular form having a tapered circular tenon at one end, a tapered circular pocket at its other end and having in its upper and lower walls longitudinally-extending mortar-receiving pockets that are relatively small in proportion to the contact surface between the upper and lower surfaces of abutting blocks, whereby a much larger amount of transparent surface is obtained than the surface covered by the mortar.

Apparatus for making sheet-glass. JOHN C. CROWLEY. U. S. 1,342,533, June 8, 1920. A receptacle for containing a prepared mass of molten glass, means, including an endless metal belt carrier and two draft drains for drawing a continuous sheet of glass from the mass of glass in the receptacle, the metal belt carrier being the means for bending the sheet, the means for supporting and carrying the sheet and the means for flattening the sheet, the metal belt carrier continuously contracting the sheet of glass from the moment that the sheet starts to bend until it is sufficiently flattened and set for the lehr, gripping chains for holding under tension a desired vertical length of the sheet's edge for maintaining a predetermined width of the sheet drawn, and means for heating a lateral portion of the bottom of the receptacle beneath the sheet source.

Machine for making hollow glass. GUSTAVE A. LEIMAN. U. S. 1,342,821, June 8, 1920. A machine comprising a vertically movable glass tube carrier and progressively operating means for heating the tube, drawing the tube to form a bulb and neck thereon, blowing the bulb, sealing the neck and tube and cutting the neck from the tube.

Process for ladling glass. HARRY F. HITNER. U. S. 1,342,960, June 8, 1920. The process consists in dipping the glass from a body of molten glass

in a metal ladle so that the glass next to the ladle is chilled, forming a plastic skin or pocket, depositing the pocket with its content of molten glass in a receptacle with the pocket intact and in contact with the walls of the receptacle and still carrying its content of molten glass, and drawing a glass article from the molten glass in the pocket.

Glass-discharging device. SYDNEY L. SEARS. U. S. 1,343,183, June 8, 1920. A device consisting of a furnace having two superposed chambers having vertically alined glass outlets, the upper chamber having a glass inlet, and independent means for heating the two chambers.

Toric-lens grinding machine. RUDOLPH H. BECK AND RUDOLPH J. BECK. U. S. 1,343,492, June 15, 1920. In a lens grinding machine a driving shaft, lens blocks rotated thereby, a yoke, posts on which said yoke is swingingly supported, means to adjustably support the posts, grinding laps carried by the yoke, and means to operatively connect the yoke with the driving shaft to effect the oscillation of the yoke.

Apparatus for supplying and grading abrasives to glass-grinding machines. JAMES W. CRUIKSHANK. U. S. 1,343,710, June 15, 1920. This covers the combination of a collecting receptacle in position to receive the abradant material and water discharged from the grinding mechanism, the receptacle having at its intake portion a plurality of preliminary grading devices through which the material passes into the receptacle and which separate and deliver the coarser material into the receptacle, and a secondary grader arranged to receive a constant volume of flow from the preliminary grading devices.

Supplying and grading sand to glass-grinding machines. JAMES W. CRUIKSHANK. U. S. 1,343,711, June 15, 1920. This describes an apparatus for supplying and grading abrading material to glass grinding machines by means of a series of grading pits.

Method of manufacturing decorated articles of glass with colored figures in the glass mass. ALBERT AHLIN. U. S. 1,343,806, June 15, 1920. The method consists in etching figures upon a colored glass layer, applying thereon an outer layer of uncolored glass and fusing the contiguous surfaces together, thereby filling up the etching.

Manufacturing ruby glass. MAX METH. U. S. 1,344,141, June 22, 1920. The method consists in mixing with the ordinary transparent glass ingredients a suitable quantity of sulphate of antimony and oxide tartar.

C. M. SAEGER.

Refractories

Resistance of zirkite to slag corrosion. ANON. *Min. Foote-Notes*, May–June, 2–8 (1920).—The effect of different materials were tested in zirkite crucibles. It was found that zirkite withstands very well the following materials: (1) The more acid slags containing manganous and ferrous oxides,

such as bessemer converter slags, puddling furnace slags, etc.; (2) glass of various kinds; (3) cobalt-nickel speiss, and (4) ladle slags that are not basic. The following materials attack zirkite moderately: (1) Ladle slags which are basic; (2) iron oxide; (3) copper oxide; (4) portland cement, and (5) litharge. The following materials destroy zirkite crucibles rapidly: (1) Iron sulphide; (2) sodium carbonate; (3) sodium hydroxide, and (4) fluorspar or cryolite. The experiments showed one important limitation in the use of zirkite, namely, the presence of fluorides or fluorine vapors. These are very destructive, particularly fluorine or vapors of hydrofluoric acid. Such vapors cause a peculiar swelling and sponginess in bricks or crucibles. H. G. SCHURECHT.

The corrosion of coke oven walls. H. V. THOMPSON. *Pottery Gaz.*, **45**, 770 (1920).—Highly aluminous clays developing a large proportion of sillimanite are much more resistant to salt attack than the ordinary fireclay brick. There seems to be possibilities in the use of aluminous fire-brick in the construction of coke ovens. The method of making silica brick greatly influence their serviceability in coke ovens. H. G. SCHURECHT.

The analysis of zirconium minerals. H. V. THOMPSON. *Pottery Gaz.*, **45**, 767 (1920).—In the analysis of Zr ores two main difficulties are encountered, namely, (1) raw Zr ores and products manufactured therefrom are not easily decompd., and (2) the separation of Al from Zr is not readily effected. It was decided to make use of the fact that after fusion with NaO_2 and decomposition of the melt with water, the residue contains all Fe, Ti and Zr in the form of oxides, together with some of the SiO_2, while the whole of the Al and the remainder of the SiO_2 is contained in the filtrate. This process possesses the advantage that Zr and Al are automatically sepd. during the process of decomposing the sample. H. G. SCHURECHT.

PATENTS

Graphite articles and method of making same. SILAS C. LINBARGER. U. S. 1,339,266, May 4, 1920. A refractory body containing graphite particles coated with a thin oxidation preventing film.

Refractory cement. STAFFORD A. MCMINN. U. S. 1,340,510, May 25, 1920. A cement composition containing not less than 33 per cent and not more than 50 per cent of powdered glass, together with fireclay.

Process of separating and extracting zirconium oxide (zirconia) from ores and minerals. JOHN GORDON. U. S. 1,340,888, May 25, 1920. The step in process of producing zirconia which consists in fusing minerals containing zirconium with a mixture of chloride and an oxide.

Process of separating magnesium from dolomite. ARDON M. MITCHELL. U. S. 1,340,905, May 25, 1920. The treatment of dolomite consisting in pulverizing the dolomite and mixing with it an alkaline hydroxide that does not react to form a compound with the calcium element.

Method of constructing one-piece fire-brick arch. WILLIAM A. A. SCHAFFER. U. S. 1,341,077, May 25, 1920. The method consists in arranging a bar or pipe through a boiler setting, anchoring the opposite ends of the bar or pipe in the walls of the boiler setting, then anchoring one end of a metallic sheet or plate in one of the walls of the boiler setting, supporting the opposite end of the sheet or plate upon the bar or pipe and then installing a mass of plastic fire-brick material upon said metallic sheet in the form of the desired arch.

Refractory arch construction. ALFRED H. WILLETT. U. S. 1,342,931, June 8, 1920. An arch construction for fire boxes comprising in combination, an arch tube, a refractory arch carried thereon, and an arch elevating brick, the brick having a tube engaging surface on one face and an arch-supporting surface and an arch abuttment on the opposite face. C. M. SAEGER.

Terra Cotta

The influence of grog in admixture with clay. W. C. HANDCOCK. *Pottery Gaz.*, **45**, 769–770 (1920).—Water of plasticity, shrinkage and tensile strength tests were made on neat clay and 80 clay mixed with 20 grog. The results with neat clay showed 18.5 per cent water, 5.4 per cent air shrinkage, 8.2 per cent fire shrinkage, 120 lbs. per square inch tensile strength for the air dried clay and 980 lbs. per square inch for the fired clay. With the 80 clay 20 grog mixtures the water of plasticity was 16.6 per cent, air shrinkage 3.8 per cent, fire shrinkage 5.0 per cent, tensile strength of air dried body 60 lbs. per square inch and tensile strength of fired body 400 lbs. per sq. inch. H. G. SCHURECHT.

Enamels

PATENTS

Method for cooling enamel. STEFAN WEISTER. U. S. 1,340,353, May 18, 1920. A method of comminuting enamel to retain its physical elasticity and also its color and to eliminate separate drying, consisting of heating enamel to form a molten mass and then discharging the molten mass in a stream and subjecting the stream to a jet of air moving with sufficient rapidity to separate the molten mass into small particles and blow the particles a sufficient distance to cool the same to such an extent that they will not adhere together. C. M. SAEGER.

Brick and Tile

Vertical fiber vitrified brick paving. C. R. MANDIGO. *Clayworker*, **73**, 700–705 (1920).—In making paving brick with an auger machine, the laminations are usually present parallel to the axis of the column. Many brick are cut so that the laminations are parallel to the pavement after they are laid, in which position they are not very resistant to traffic. C. E. Fuller developed

a brick in which the laminations are perpendicular to the pavement in which position the brick are more resistant to wear. In making these brick the column is cut across the $4^1/_2$ inch face. In firing there was a tendency for the ends to laminate. This defect was overcome by increasing the length of the die to $13^1/_2$ inches and cutting $2^1/_2$ inches from each side of the column before it went to the cutter. These brick are laid on their $4^1/_2$ inch. side and are made in $2^1/_2$ inch, 3 inch and 4 inch depths. These brick were adopted as standard by the Western Paving Brick Manuf. Assoc. in 1912 and recently by the National Paving Brick Manuf. Assoc. H. G. SCHURECHT.

PATENTS

Mold for bricks and blocks. STOYAN V. TSANOFF. U. S. 1,338,468, April 27, 1920. A frame of three sides having guide flanges adapted to coöperate with another similar frame to form the fourth side of the mold.

Apparatus for making bricks. HENRY W. B. GRAHAM. U. S. 1,341,798, June 1, 1920. This machine is so designed as to pass a mold to be filled with brick mixture to be pressed and then discharged from the molds, which are used continuously. C. M. SAEGER.

Abrasives

Method of making abrasive structures. CHARLES W. THOMAS. U. S. 1,338,598, April 27, 1920. The method consists in mixing abrasive grains with a temporary binder, and a permanent binder consisting exclusively of preshrunk vitreous material; firing the object at a temperature sufficient to cause the permanent binder to flow, and cooling the object.

C. M. SAEGER

Cement and Lime

Lime—its properties and uses. Cir. Bur. Standards, No. 30, 2nd edition. —This circular is intended to give general information as to what lime is, how it is made, and what it is used for. Lime is made by heating limestone under certain conditions. This lime, when treated with water, hydrates or slakes. If water is used in great excess, a paste results; but if the amount is properly regulated, the hydration yields a dry powder, which is called hydrated lime. Since natural limestones contain more or less magnesia, iron, silica, etc., the quality of the lime will depend to some extent upon the nature and amount of these foreign materials. It will also depend upon the way in which the stone is burned. As a material for building construction, hydrated lime is better adapted than quicklime because it eliminates labor usually required to do the slaking. It is used very largely as a brick mortar, as an ingredient in concrete and in the scratch and brown coats of plaster. A particular grade of hydrated lime, noted for its plasticity, is sold as finishing lime and is used for the white coat of plaster. Limestone, quicklime, and hydrated lime are used to a large extent as chemical reagents in the manufac-

ture of other materials. In some of these industries the quality of the lime is of minor importance. In others, the use of only one of the three forms of lime is satisfactory, and the quantity and kind of impurity which the lime may contain is definitely specified. Eighteen of the most important chemical industries that use lime are enumerated. Brief descriptions of these industries are given, showing why and how they use lime, and the quality of lime which they require. A list of the tests of lime which are usually made includes chemical analysis, rate of hydration, plasticity, sand carrying capacity, time of set, compressive strength, proportion of waste, and fineness.

E. M. HARRIS.

PATENTS

Method of manufacturing simultaneously hydraulic cement and alkali from alkalifereus mineral substances and lime. ERNST WALDEMAR JUNGER. U. S. 1,338,021, April 27, 1920. The method consists in heating a mixture of the substances by means of fuel to a temperature at which the carbonic acid is driven off, then completing the burning by means of electrically generated heat at a temperature at which the alkali is driven off and substantially without access of air, and separately collecting the alkali and the residue.

Non-porous cement. FRANCES DAVID MULLIGAN. U. S. 1,338,033, April 27, 1920. A compound for water-proofing and strengthening cement comprising a mixture of slaked lime and raw linseed oil in the proportion of 20 ozs., by weight, of lime to 3 ozs., by weight, of oil which mixture is added to the cement.

Cement. DAVID W. ADAMSON. U. S. 1,338,117, April 27, 1920. A cement comprising calcined and comminuted gypsum and calcined alunite ores.

Combined cement. KARL L. TORNO BERKELEY. U. S. 1,342,360, June 1, 1920. A cement comprising portland cement and dehydrated calcium sulphate and potassium sulphate.

C. M. SAEGER.

ACTIVITIES OF THE SOCIETY

New Members Received During June

Bonner, James M., Jr., Robinson, Ill., Assistant Manager, Zwermann Company.

Caruthers, Raymond G., Blandburg, Pa., Assistant to Superintendent, Harbison-Walker Refractories Company, Production Department.

Dalton, Richard F., Long Island City, N. Y., President, New York Architectural Terra Cotta Company.

Geer, Walter, Jr., Long Island City, N. Y., Vice-president, New York Architectural Terra Cotta Company.

Hawke, C. E., Niagara Falls, N. Y., Sales Manager, Refractory Department, The Carborundum Company.

Hays, George H., Cleveland, Ohio, Assistant Manager, The Vitreous Enameling Company.

Kennedy, John H., 114 Hubbel St., Canandaigua, N. Y., Assistant Superintendent, Lisk Manufacturing Company.

Martin, Victor L., Washington Ave., Charleroi, Pa., Macbeth-Evans Glass Company.

Wry, Thomas A., Lynn, Mass., General Electric Company.

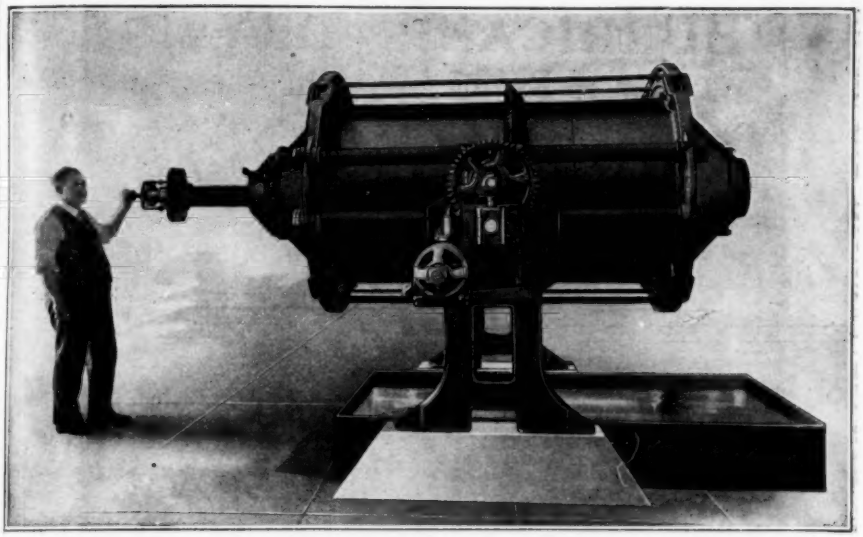
Foreign

Gunn, James, 59 King Edward Ave., Toronto, Canada, Chemist, Canadian General Electric Company.

Important Actions of the Board of Trustees

July 13.—It was voted to authorize the Treasurer to invest $3,000 in the next issue of U. S. Treasury Certificates.

July 13.—Mr. S. C. Linbarger, of the Carborundum Company, Niagara Falls, N. Y., was appointed chairman of the Committee on Sections and Divisions.



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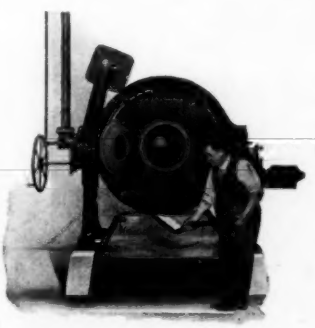

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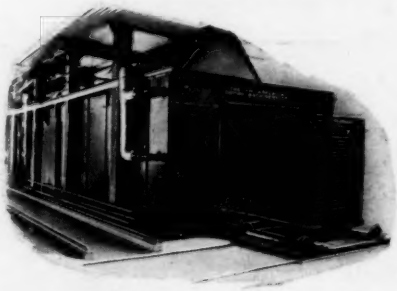

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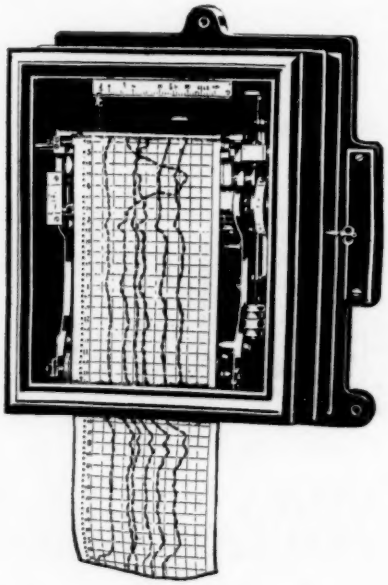

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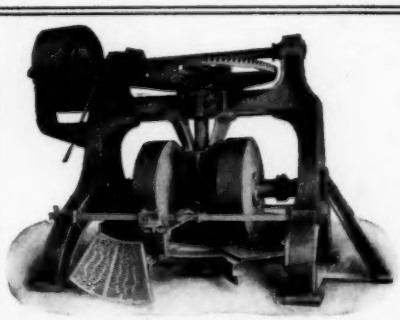

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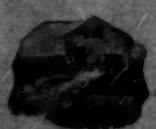

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PART II

Vol. 3 AUGUST, 1920 No. 8

Journal

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A Monthly Journal devoted to the Arts and Sciences Related to the Silicate Industries

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1918-1919 1919-1920

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C. H. Kerr, *Councilor*

Central Ohio Section

F. K. Pence, *Chairman* **John M. Morton,** *Secretary*
A. S. Watts, *Councilor*

Chicago Section

W. D. Gates, *Chairman* **Fred B. Ortman,** *Secretary*
C. W. Parmelee, *Councilor*

New York State Section

L. E. Barringer, *Chairman* **J. B. Shaw,** *Secretary*
C. F. Binns, *Councilor*

Pittsburgh District Section

R. R. Hice, *Chairman* F. H. Riddle, *Secretary*
F. W. Walker, Sr., *Councilor*

COMMITTEES, 1918-1919

Committee on Publications

L. E. Barringer, *Chairman*
G. H. Brown, *Editor*
H. Ries
A. V. Bleininger
E. W. Tillotson

War Service Committee

A. F. Greaves-Walker, *Chairman*
A. V. Bleininger
L. E. Barringer
A. S. Watts
C. H. Kerr
R. H. Minton
C. F. Binns
E. W. Washburn
R. T. Stull
R. D. Landrum

Committee on Membership

R. C. Purdy, *Chairman*
R. D. Landrum
R. L. Clare
F. B. Ortman
T. H. Sant
R. H. Minton
R. D. Hatton
F. H. Riddle
F. K. Pence
J. B. Shaw

Committee on Standards

M. F. Beecher, *Chairman*
C. H. Kerr
J. B. Shaw
E. P. Poste
E. E. F. Creighton
C. W. Berry
F. H. Riddle
R. M. Howe
C. F. Binns
H. Wilson
R. K. Hursh
F. A. Kirkpatrick
C. B. Harrop
G. H. Brown
R. T. Stull

Committee on Coöperation

C. H. Kerr, *Chairman*
G. E. Barton
W. E. Emley
J. P. B. Fiske
W. D. Gates
C. T. Harris
E. Hart
F. R. Henry
D. F. Riess
K. Seaver
C. L. Sebring
F. W. Walker, Sr.

Committee on Rules

C. W. Parmelee, *Chairman*
A. S. Watts
F. H. Riddle
S. G. Burt
A. F. Greaves-Walker

Committee on Local and Student Sections

R. R. Hice, *Chairman*	F. K. Pence
W. D. Gates	H. A. Wheeler
M. E. Gregory	

Committee on Chemical Exposition

L. E. Barringer, *Chairman*	R. D. Landrum
R. C. Purdy	H. Schmidt
C. H. Kerr	A. Staudt
K. Seaver	H. Ries
C. F. Binns	R. T. Stull
P. H. Swalm	R. H. Minton
F. B. Ortman	

Committee on Papers and Programs

R. H. Minton, *Chairman*	A. E. Williams
A. A. Klein	C. E. Jackson
R. T. Stull	W. E. Emley
P. H. Bates	E. T. Montgomery
E. P. Poste	D. T. Farnham

Committee on Summer Session

F. K. Pence, *Chairman*	E. Ogden
C. W. Berry	R. D. Landrum
C. D. Fraunfelter	J. W. Sanders

REPORT OF THE BOARD OF TRUSTEES, 1918–1919

The Board has found the past year to be one of strenuous activities. It was determined at the outset that each member of the Board should assume a more direct share in the affairs of the Society than had ever before been the case. In order to give effect to this policy it was, of course, necessary to conduct an unusual amount of correspondence and the expenditure upon postage and telegrams has been much larger than in former years. In this connection it may be of interest to note that 36 motions were voted upon by the Board, by mail and wire, in addition to numerous discussions which did not come to a vote. There has also been a large accession of members, to every one of whom, upon entrance, a personal letter has been written. The Board believes that this policy is justified and expects that it will be continued. The work of the Standing Committees is a new development and, while the results of this work have been most important and reflect great credit upon the personnel, the work of the Board and of the Secretary's office has been greatly increased. These Committees as well as the Sections and Branches are rendering their own reports so that the Board will not do more than express appreciation of the devotion and enthusiasm of the workers.

An important step has been taken in the formation of seven professional

divisions—Glass, Enamel, Pottery and Porcelain, Refractories, Brick and Tile, Terra Cotta and Faience, Abrasives. A chairman has been appointed for each division, with the power to select his own committee. It is expected that much practical benefit to the different phases of the industry will result from this action.

At the Fourth National Exposition of Chemical Industries held in New York in September, the Society secured space, and also was instrumental in the assembling of the ceramic interests in one section. The Society booth was visited by a considerable number of members and other persons.

The publication of the monthly Journal, taking the place of the annual volume of Transactions, has increased the interest in the work of the Society and has met with general approval. The necessary monthly revision of the mailing list has involved additional labor but this has been successfully carried through.

The revenue made available by additional income has not been allowed to lie idle. The Board authorized the Treasurer to invest $3000 in the Fourth Liberty Loan and $2000 in U. S. Treasury Certificates.

The membership has passed the thousand mark, and especially gratifying is the accession of forty-four Contributing Members, representing a financial gain of $1100, a result which is due to the personal work of members, some of whom achieved a really phenomenal success in the matter.

Financial Statement

YEAR ENDING FEBRUARY 1, 1919

RECEIPTS

Brought forward, Feb. 1, 1918	$ 3,103.80
Dues and fees (Active and Associate)	5,498.42
Dues (Contributing)	1,500.00
Sale of Transactions	1,196.73
Subscriptions to Journal	349.46
Advertisements in Journal	2,397.60
Credit, Section Q (1918 Annual Meeting)	40.00
Sale of Seger's "Collected Writings"	75.00
Sale of "Directory of Dealers"	31.00
Reprints	125.30
	$14,317.31

DISBURSEMENTS

Accounts standing over, printing, etc	$ 168.50
Auditor, Feb. 1918	45.53
1918 Annual Meeting expense	419.20
Office equipment	314.90
Publishing 8 numbers of Journal	2,878.61
Salaries	1,894.97

Printing "Directory of Dealers"	130.50
Chemical Exposition expense	100.00
Binding volumes in cloth	84.35
Storage and handling volumes	75.69
Seger's "Collected Writings"	72.66
Committee supplies, etc	287.31
Secretary's traveling expenses	147.90
Editor's office expense	157.27
President's office expense	42.85
Postage, Treasurer	3.00
Membership dues, N. F. P. A.	30.00
Secretary's office expense	520.38
Reprints	112.00
1919 Annual Meeting	25.00
Investment in 4th Liberty Loan	3,000.00
Investment in U. S. Treasury Certificates	2,000.00
Bank charges for exchange and lost check	5.52
	$12,516.14
Balance on hand	1,801.17
	$14,317.31

Membership

MEMBERSHIP, FEBRUARY 1, 1918.	
Honorary members	4
Life members	1
Active members, resident	79
Active members, foreign	9
Associate members, resident	568
Associate members, foreign	56
Contributing members	33
TOTAL	750
MEMBERSHIP, JANUARY 1, 1919.	
Honorary members	4
Life members	2
Active members, resident	100
Active members, foreign	11
Associate members, resident	722
Associate members, foreign	72
Contributing members	73
TOTAL	984

CHAS. F. BINNS, *Secretary*

"In Memoriam" 1918-1919

C. W. Hathaway

A. L. Jensen

B. F. King

Owen Carter

H. J. Lundgren

W. A. Kemp

John Shanks

REPORTS OF LOCAL SECTIONS, 1918–1919

Northern Ohio Section

Following the appointment of the organizing leaders for the various local sections of the Society an organization meeting for the Northern Ohio District was called for Dec. 10, 1917, in Cleveland. The business features of the meeting included the election of temporary officers and the preparation of an application for a charter for the Northern Ohio Section.

At the next meeting held in Toledo the charter was presented to the Section by Prof. C. W. Parmelee. The following officers were elected: *Chairman*, E. P. Poste, Elyria, Ohio; *Secretary-Treasurer*, B. A. Rice, Elyria, Ohio; *Councilor*, R. D. Landrum, Cleveland, Ohio.

Two subsequent meetings have been held, at which a set of by-laws were discussed and adopted. They call for meetings the first Monday in April, June, October and December. The above officers were re-elected for the year 1919.

The meetings took place in the afternoon and evening, and two of the evening meetings were joint meetings with the Cleveland Section of the American Chemical Society, for which we furnished speakers, Mr. A. A. Klein and Dr. E. W. Washburn.

In general the activities of the Section may be summarized as follows:

No. of meetings	4
No. of papers presented	11
No. of plants visited	4
Average attendance	14
No. 1918 dues paid	15

Through the activities of the Section several new memberships have been obtained, and an effort to obtain contributing memberships has been partially successful.

Respectfully submitted,

EMERSON P. POSTE, *Chairman.*

St. Louis Section

A meeting of the St. Louis Local Section was held at the Washington Hotel, St. Louis, on January 24, 1919. The following officers were elected: Chas. W. Berry, *Chairman;* Gail R. Truman, *Secretary;* Dwight T. Farnham, *Councilor.* A gain of eight new members during the year was reported.

Informal discussion brought out the fact that the St. Louis Section had a very great opportunity for growth and advancement.

GAIL R. TRUMAN, *Secretary.*

New England Section

Organization.—The New England Section was organized December 14, 1917, at Worcester, Mass. Officers were elected and plans for future meetings were discussed.

Meetings.—Four meetings have been held and the places, dates and attendance are here recorded:

First meeting at Norton Co., Worcester, Mass., December 14, 1917, about 15 attending.

Second meeting at Boston City Club, Boston, Mass., April 13, 1918, about 21 attending.

Third meeting at Engineers Club, Boston, Mass., May 18, 1918, about 24 attending.

Fourth meeting at Boston City Club, Boston, Mass., Jan. 11, 1919, about 20 attending.

The regular procedure at each meeting is to have dinner together at 7 o'clock and the program follows at about 8 o'clock. At the fourth meeting, January 11, 1919, the party visited the A. D. Little, Inc., Laboratories at 4 o'clock and spent a pleasant and profitable two hours inspecting the equipment and work of this up-to-date consulting chemical laboratory.

Programs.—At the four meetings that have been held to date the programs were:

First meeting, December 14, 1917, R. C. Purdy on "Influence of Scientific and Technical Societies on the Development of Man and Industry."

Second meeting, April 13, 1918, H. E. Howe on "Optical Glass."

Third meeting, May 18, 1918, A. V. Bleininger on "New Ceramic Materials and the War."

Fourth meeting, January 11, 1919, C. H. Kerr on "Some Problems of the Glass Manufacturers." Carl H. Lawson on "Clay Testing, Methods and Purposes."

At each meeting there were very interesting discussions not only of the papers presented but of any and every subject of interest to the members in attendance.

C. H. KERR, *Councilor.*

Central Ohio Section

The Central Ohio Section of the American Ceramic Society held four meetings during the past year. In spite of the general handicap, there was an average attendance of thirty, an addition of over twenty-five members to the parent Society, and a wholesome development of interest among local clay manufacturers. This was also evidenced by the cordial support given the local committee in entertaining the Summer Meeting.

Among those addressing the Section during the year were Philip Dressler, F. H. Rhead, A. S. Watts, A. V. Bleininger R. T. Stull and F. H. Riddle.

At the February meeting, officers were elected for the coming year as follows: F. K. Pence, *Chairman;* C. D. Fraunfelter, *Vice-Chairman;* J. D. Whitmer, *Secretary;* J. M. Morton, *Treasurer;* A. S. Watts, *Councilor.*

F. K. PENCE, *Chairman.*

REPORTS OF COMMITTEES, 1918–1919

Committee on Publications

The Committee on Publications was appointed by President H. F. Staley in February, 1918, and was comprised of the following members: L. E. Barringer, *Chairman;* G. H. Brown, A. V. Bleininger, H. Ries, E. W. Tillotson.

It was felt that before taking positive steps in the work, particularly of publishing a Journal, the Committee should await confirmation of the new rules. Several weeks elapsed before the rules were approved, and they were free to proceed with the main business of starting the publication of a monthly journal.

The first meeting of the Committee was held in Pittsburgh

at Mellon Institute on April 26, 1918. It was an all-day meeting at which consideration was given to a great many questions—the proper size and form of the Journal, the proper subject matter to be printed, the question of advertising, the price, the amount of space to be devoted to this purpose, and the consideration of bids which had been received for printing. The last question involved particular difficulty because of the irregular schedule, and this reason alone reduced the number of bidders to two. Not many printing establishments were willing to undertake to issue twelve numbers at irregular intervals between July and January. Then there was the policy to be decided regarding the selection of papers. Most of these matters were soon well cleared up, however, and it was decided to have the Editor proceed in making a final selection of the publishing house.

The second meeting of the Committee was held also in Pittsburgh on May 24, at which time a contract was approved with the Eschenbach Printing Company, of Easton, Pa. At that meeting the schedule for the first six numbers was arranged, spaced approximately two weeks apart. In June the first difficulty was encountered in the fact that the military draft took four men out of the monotype department of the printing house, whose organization was thereby disrupted and there was a delay of two or three weeks in publishing the first number. The first number of the Journal appeared July 15, 1918. There was enough matter on hand for the first few numbers and everything went smoothly for a while, but by September it was found that the numbers were falling behind, because of the fact that the Editor did not have enough material on hand.

A third meeting was held in New York City, September 26, to which Prof. Binns, Mr. Minton, and President Staley were invited. An energetic policy was adopted whereby enough high-grade papers to finish out the first volume might be secured. That policy was carried out and eventually enough material was provided to complete the first volume. In Volume 2 it is probable that the greater part can be issued upon the proper basis of having one number a month.

The December, 1918, number was made the Society's Year Book, containing the names of the members of the Society,

the make-up of the various committees, the rules, reports, and other matters pertaining to the Society. In the second volume the Year Book will appear as a separate number and will be paged separately so that it will not enter as a number of the Journal, which is strictly a technical magazine.

The fourth meeting of the committee was held in Pittsburgh, February 5, 1919, when were discussed various questions which had arisen during the year. The question of abstracts, both of ceramic literature and of patents, was brought up, and the Committee wishes to state that it is not opposed at all to such a scheme of abstracting, but simply wishes to find the best way of satisfactorily conducting such a department. It is not an easy task and will involve a definite organization to be responsible for abstracting of the literature that is wanted and for producing the proper kinds of abstracts.

Some of the members have suggested a question and answer box. Such a departure is attended with even greater difficulty. It is very easy to ask questions through the Journal, but frank and honest answers by capable men are more difficult to bring about, and this matter will probably be held in abeyance for some little time. The question of having a part of the Journal devoted to the needs of the Society has already been acted upon favorably, and this feature has appeared in the last few numbers.

The cost of such proposed new work must be taken into consideration. When the Journal was first started it was agreed that an endeavor should be made to secure enough advertising to pay for the publication of the Journal, and not to wait for more than that amount. The policy was simply to offset the cost of the Journal by the revenue from advertisements. Friends of the Society who were in the business of manufacturing ceramic supplies were approached and a sufficient number took advertising space in one and two-year contracts, "on faith." There was no established advertising medium to present to these firms at that time, but it can now be shown that the Journal *is* a good advertising medium.

The following is a statement of the receipts from advertising and the cost of publication of the twelve numbers of Volume 1 of the Journal:

Paid to Eschenbach Printing Company.....	$4283.97
Receipts from advertising.....	3902.40

All the bills for advertising in Volume 1 have been paid with the exception of $24.00.

This statement does not include the salaries and expenses of the editorial office. The salaries from April 1, 1918 to April 1, 1919, amounted to $1713.33. The personal expenses of the editor, including postage, telephone and telegrams, etc., amounted to $123.25. This does not include bills for stationery, etc., which were forwarded to the Secretary.

From the preceding it will be noted that the net cost to the Society for the publication of Volume 1 of the Journal amounted to about $2300.00. The cost of publication of Volume 19 of the Transactions was $2781.88. The net cost of publication of Volume 1 of the Journal was, therefore, $481.00 less than the cost of publication of Volume 19.

In addition to the revenue from advertising there is the revenue from paid subscriptions which must be regarded as properly revenue from the Journal, for it may be assumed that these subscribers have recognized the merits of the Journal and desire to have this publication, aside from any consideration of membership in the American Ceramic Society. At the time of completing Volume 1 there were 81 paid subscribers, representing a revenue of $486 annually. Deducting this from the previous figure leaves a final net expense of approximately $1800 for the publication of Volume 1 of the Journal of the American Ceramic Society.

There are now about 870 copies of each number on hand, out of which 400 copies of each number are reserved by action of the Board of Trustees to be sold in sets, leaving only a small margin for the sale of single copies of each issue. In view of this, it has been decided to increase the number of each issue from 1800 to 2000.

The Committee feels that while there is a surplus and the undertaking has been a success financially for the first volume, this is not the time to find some way to spend this money. A reserve is needed upon which to finance Volume 2. Most of the advertisements are based upon one-year contracts. If these should not be renewed, the reserve fund might have to be drawn upon.

There are other expenses which will develop in connection with abstracting and other features which will require finances. The Committee, therefore, asks that enough surplus be reserved to meet needs brought about either by reduced revenue or by increased expense of new departments.

The Committee has held four meetings and at each one there was an attendance of 100% of the membership of the Committee. This indicates the zeal of the Committee and the feeling upon the part of each member that he has a distinct responsibility. The Editor has given very faithful service to this work. He has been confronted by a great many difficult circumstances but has handled the matter in a very creditable way, and the Committee feels that a very considerable part of the credit for Volume 1 is due to the services of Mr. Brown.

L. E. BARRINGER, *Chairman.*

War Service Committee

The Committee held no meetings during the year but a large amount of valuable and very helpful work was done by the members individually or in connection with government departments, bureaus and committees for which credit is due the Society.

Mr. Bleininger accomplished a great deal of splendid work in connection with refractories. Special mention should be given to his work on glass pots for the optical glass industries, special refractories for the Navy Department, and special refractories for the metallurgical industries. He also gave very great assistance to the refractories manufacturers of the country in helping them to solve the many war problems which confronted them, among which was the standardization of fire-brick specifications. Aside from the work of his sub-committee he did a great deal of very valuable work in other directions, including optical glass, chemical glassware, and chemical porcelain.

Dr. Washburn gave unreservedly of his time to work in connection with the National Research Council, devoting his efforts principally to ceramic chemistry. It was largely due to his efforts that the ceramic courses were so adjusted as to be accepted as essential by the War Department.

Professor Watts did very excellent work in the investigation

of the kaolins of the country which were so badly needed when much of the European raw material was cut off by the war. He also kept the Directory of Dealers in Ceramic Raw Materials revised. The value of this work can only be fully appreciated by those who found it necessary to seek entirely new sources of supply through the changes in trade channels brought about by the war.

Mr. Stull did most valuable work in connection with the graphite crucible investigation, kaolin investigation, and dolomite, magnesite, and chrome investigation. These investigations were carried on at the request of the War Industries and Shipping Boards.

Mr. Kerr gave much valuable assistance individually to the optical glass industry. To a very large extent much of the work he might have done was in the hands of another member of the Committee, Mr. Bleininger.

Professor Binns gave much valuable aid to the infant chemical porcelain industry, this aid consisting principally of advice to those applying for it. The experience of Professor Binns undoubtedly added greatly to the success attained by American manufacturers of this product.

Mr. Landrum organized the manufacturers of enameled ware to such an extent that the Army and Navy requirements were promptly taken care of. He also assisted in the working out of specifications for the Army and Navy and these specifications were used by the officials in making contracts and purchases.

Mr. Barringer took a very active interest in the development of porcelains for spark plugs to be used in airplane engines. Suggestions were made to manufacturers as to improvements in body compositions, materials to use for center electrodes, methods of cementing center electrodes, and cements to be used for this purpose.

Mr. Minton organized the manufacturers of chemical stoneware for the purpose of securing and distributing the supply of coal, wood, clay, forms, etc., among those holding government contracts. He also secured priority orders for these materials and secured shipments when urgently needed.

Mr. Purdy organized the manufacturers of abrasives immedi-

ately upon the outbreak of the war, with the result that at no time did the industry run short of much needed raw materials. He gave to this organization information of the greatest value regarding bond clays, saggers, etc. He also solved the very important problem of an abrasive suitable for the grinding and finishing of optical glass required for binoculars, range finders, gun sights, etc., thus making us independent of the European supply.

The Chairman of the Committee was requested by Dr. Garfield early in the year to join the U. S. Fuel Administration. Upon acceptance of the appointment he was assigned to take charge of the Curtailment Section. He immediately proceeded to issue the fuel orders covering the ceramic and other industries. With this work practically completed he was appointed Chief of the Industrial Furnace Section. In order that the Administration might have the benefit of the advice of the Society as a whole, Dr. Garfield appointed the Society, with the consent of the Trustees, as counsellor to the Industrial Furnace Section. During this period much assistance was given to individual ceramic concerns by the Chairman in securing fuel priorities, fuel allotments, and permits to change from less essential to more essential products.

Aside from the work of the Administration, the Chairman was called into consultation on ceramic problems by the War Department in connection with refractories for the Chemical Warfare Service, the Navy Department in connection with steel furnace construction, the War Industries Board, Shipping Board, and War Trade Board.

Early in the year efforts had been made to have a member of the Society appointed to the staff of the War Industries Board. Soon after his appointment to this Committee the Chairman took this matter up personally with Mr. Bernard M. Baruch with the result that the Society received proper recognition and President Homer F. Staley was appointed as Ceramic Advisor to the Board. His work on the Board was of great value and was highly commended by the various section chiefs. It is of interest that President Staley was the only representative of a technical society appointed to the Board as such.

At the time the Ceramic Courses of the various colleges were in danger of being declared non-essential, the Chairman enlisted the interest of Dr. Garfield with the result that he took the matter up with President Wilson and various officials of the War Department and secured recognition for them equivalent to other preferred courses.

A. F. GREAVES-WALKER, *Chairman.*

Committee on Standards

Sub-Committee on Electrical Insulators

High tension porcelain must be distinguished from molded insulation suitable for low voltage work. Both low and high frequency tests are being used for porcelain, the latter being the more severe.

It is recommended that certain general tests common to ceramic products be selected, together with special tests suitable to insulation material for various purposes, and that these be combined to provide a set of standard tests for porcelain, and for other types of insulation, with distinction as to the character of service which they are to give.

Sub-Committee on Sheet Steel Enamels

A circular letter was sent to enamel manufacturers requesting coöperation, but received poor response. At the summer meeting it was decided to supplement the committee by three advisors, a practical enameler, a man with some technical experience, and a ceramic technologist engaged in the enameling industry. The names were not announced.

A test for resistance to acids was presented in a paper by E. P. Poste, to be published in the Journal. It is expected that the publication of this work will bring forth constructive criticism to aid in the future work of the committee.

Sub-Committee on Chemical Porcelain

Only one test had been proposed as a substitute for those presented last year. This referred to the chemical action of alkalies based on the accurate measurement of area rather than the weight of the piece.

The quenching test is not considered to give just results while the dry blast test as previously recommended apparently gives a good comparison between samples. Mr. Riddle suggests that his results by this method have not been satisfactory, but he has found good results by heating an ordinary crucible containing $^1/_4$ inch of water on a gauze until evaporated to dryness. Good bodies have withstood this test 25 times, while poor bodies have failed after three evaporations.

Professor Binns states that the limiting factor at present in the manufacture of chemical porcelain is in the refractoriness of the saggers. The mechanical quality of American ware is equal to any other. Manufacturers seem inclined to coöperate in the work and to be willing to use tests recommended.

Sub-Committee on Clay-Sampling

Data are not available upon which to base tentative standard methods for plasticity tests. The committee, therefore, requests continuance on this work.

It was suggested that a method of sampling of material in containers be changed to specify for lump material, the same gross sample and method of sampling, as in car lots of loose material

Sub-Committee on Slagging Tests for Refractories

At the present time no slag penetration test has been developed which will distinguish between acid, neutral, or basic bricks and indicate which is the most suited for certain purposes. Fireclay bricks, which give the best penetration tests, are not necessarily the most suited for metallurgical purposes. In view of these conclusions the penetration test appears to be limited in its usefulness to:

1. Indicating the best grinds of the same clays.
2. Indicating the best mixes (within limits) of the same clays.
3. Indicating the best processes for manufacturing metallurgical brick made from the same clays.
4. Indicating the best firing treatment.

Sub-Committees on Tests by 1917 Tentative Methods and Correction and Revision of Matter in 1917 Report

The revised specifications for tests, together with an explanatory

appendix will be submitted later. It was suggested that an introduction be provided immediately preceding the testing methods, which will explain the purposes of the tests and will specify the total number of test pieces, their size, and the weight of material required. The Committee has suggested dropping linear shrinkage measurements and using volume measurements only.

The committee recommends that some of the tentative methods of 1917 be adopted as standards, that some be retained as tentative, and that some be amended. Details will appear in the separate report to be published soon.

M. F. BEECHER, *Chairman.*

Committee on Coöperation

Due to the pressure of war activities, which took the major part of the energies of every member of the Committee on Coöperation during the year, comparatively little work has been done. There is presented herewith a very brief summary showing the interests and activities of this committee during the year.

National Exposition of Chemical Industries.—Mr. W. D. Gatès is the only member of this committee living in Chicago and he has kindly consented to arrange with the Exposition Management as to location of booth for the Society, the space being donated to the Society and further to arrange for a local committee in Chicago to look after details in connection with the Exposition.

Publication Notices.—When the monthly Journal of the Americal Ceramic Society started, the Committee on Coöperation sent to 35 of the most prominent Technical Journals of the United States and a few abroad, a general notice of the nature and growth of the American Ceramic Society, a description of the previous Transactions, a statement of the reasons and plans in connection with the new monthly Journal and a request that suitable review of the entire situation be published. Sample copies of the first issue were also sent. In response thereto, a great number of such reviews were published which called attention to the work of the American Ceramic Society and the excellent character of its new Journal.

Journal Exchanges.—The Society of Glass Technology in Eng-

land publishes a quarterly Journal which is of great interest in the glass industry and recognizing the value of that publication, it has been arranged through the Secretary to exchange with that Society.

The Literary Digest.—Mr. Warren E. Emley, a member of this Committee, brought to the attention of the Chairman the fact that the *Literary Digest* was establishing a Department of Chemical Industries and in response to an inquiry the publishers of the *Literary Digest* expressed great interest in our ceramic work and especially in our new Journal. It has been arranged to have our Journal sent regularly for their examination and this will doubtless be indirectly of some advantage to the Society.

Speakers.—The question has been fully discussed and it is hoped that we may arrange to have speakers interested in the American Ceramic Society and acquainted with the problems of the silicate industry appear at various Societies, Clubs, etc., and in connection with some general paper, call attention to the Society's make-up and activities and thus stimulate interest in coöperation among the people interested in the silicate industries. Only a start has been made, but we are confident of excellent results along this line in the future.

Relations with Other Societies.—Probably the chief duty of this Committee is to represent the Society in its relations with other Technical organizations and this activity has many phases. One activity just started is in coöperation between the Society of Glass Technology in England and the Standards Committee of the American Ceramic Society in reference to standard methods of testing glass house refractories. This should develop into a real coöperation between the two Societies.

Another activity is in the correlating of the work of the American Society for Testing Materials with that of the Standards Committee of the American Ceramic Society and considerable has been accomplished along that line especially in matter of standard methods for the load test, ultimate analysis, etc. This work will doubtless enlarge greatly.

Another activity carried out chiefly by Mr. Charles L. Sebring has been in arranging for a joint meeting with the U. S. Potters Association and the American Ceramic Society, this joint meeting

to take place February 4, 1919. Mr. Sebring has presented to the U. S. Potters Association the advantages of coöperation with the American Ceramic Society and I am very confident that great good to both organizations will come from this coöperative effort.

In the case of the National Lime Manufacturers Association, Mr. Warren Emley has been following with that Society the question of mutual coöperation between the two organizations. As a result of these activities, Mr. Emley and Mr. Staley met with the officers of the National Lime Manufacturers Association on January 23 and the best possible arrangements have been made in an informal way for coöperation. In addition to this the National Lime Manufacturers Association will hereafter recognize the Journal of the American Ceramic Society as the official organ for their technical publications. The coöperation thus established between the two Societies is certain to lead to results beneficial to both.

In the case of the National Brick Manufacturers Association, the relations have always been exceedingly pleasant and cordial and the meeting of the two organizations at the same time at Pittsburgh this year will be conducive to very close association of interest.

The above outline is intended to show the general nature of the activities during the past year and a continuation and enlargement of such activities is contemplated during the coming year.

C. H. KERR, *Chairman.*

Committee on Rules

The Committee presented a careful revision of the Rules verbally at the Annual Meeting. These were issued later to the Active Members for their vote, and the revised Rules, which were passed by a large majority, are incorporated in this Year Book.

C. W. PARMELEE, *Chairman.*

Committee on Local and Student Sections

The Committee has considered the particular case of the New Jersey charter and also the general problem of geographical distribution. There were two questions that arose in regard to the

New Jersey Section, the name and the territory. In regard to the name, the Committee thinks that there is very good reason for the acceptance of the suggested name, the New Jersey Clay Workers' Association and Eastern Section of the American Ceramic Society, and would recommend that the body be thus incorporated. The name is burdensome and it is likely that some of it will be cut off later. The matter of territory to be included was considered and the committee recommends that the city of New York be taken away from the New York State Section and turned over to the Eastern Section because of the close affiliation of the clay people in New York City with the New Jersey interests. A portion of eastern Pennsylvania, Delaware, and the eastern shore of Maryland should also be added to the Eastern Section the exact line depending upon the grouping of ceramic industries there and the railroad connections with New Jersey.

In connection with the various local sections, the suggested lines dividing the sections were made a year and a half ago and are rather indefinite. The Committee recommends that the incoming committee take up a study of this situation. The geographical relations of these sections, the membership of the Society and the ceramic industries in each of these districts should be noted and a settled line drawn cutting the country up into appropriate sections, none of them too large.

R. R. HICE, *Chairman.*

Committee on Fourth National Exposition of Chemical Industries

The American Ceramic Society was creditably represented at the Fourth National Exposition of Chemical Industries, held in New York City, September, 1918.

The Society exhibited data charts, publications, etc., in a double booth, and considerable interest was shown in its work. One hundred twenty-six names were written in the register kept at the booth for recording visitors. As a matter of knowledge, one Corporation and three Associate memberships were secured during the week of the Exposition.

From the point of view of publicity it seems quite worth while to have the Society represented in such expositions, and even

as a matter of direct benefit the small expenditure seems quite justified.

The net expenditures amounted to $57.90. These included the renting of furniture, the making of charts and signs, freight and cartage, janitor service, postage, and telephone.

L. E. BARRINGER, *Chairman.*

Committee on Papers and Programs

The activities of this Committee during the past six months have been quite strenuous. In addition to the function of providing papers for the annual meeting it has had to procure a considerable number of the contributions for the current issues of the Journal, on account of the publishing of twelve numbers within a period of six months. Ten numbers of Volume 1 have already appeared and the subject matter is in hand to complete the entire twelve numbers. In addition to these papers, there were procured for the 1919 annual meeting 58 additional papers.

On account of war activities, research work has been limited during the past year. Particularly have some former prolific sources of supply in the universities been greatly reduced, and it has been found necessary to try to develop new centers of production.

More than eight hundred letters and cards were sent to members in preparation for the annual meeting, and only seventy replies were received. A systematic effort should be made to stimulate a greater spirit of contributing among the membership at large.

As a result of experience this committee makes the following recommendations to the Society and to the succeeding committee:

First.—According to the Rules this committee shall consist of the chairmen of the various Divisions, the secretary of the Society, and other members as shall be designated. It is recommended that the committee also include the secretaries of the Local Sections, and represenatives from the various bureaus and laboratories doing research work.

Second.—It is recommended that the duties of this committee be confined to the arrangement of the annual program only.

and that the procuring of additional papers for the Journal be left to the Editor and the Publication Committee.

Third.—It is recommended that this Committee start early in the year to arrange a tentative program for the annual meeting. A program should be decided upon to include papers on all of the various industrial and scientific divisions of ceramics, and in that way a well-balanced program may be mapped out.

Fourth.—It is recommended that the papers that may have been published in the Journal previous to the annual meeting shall appear on the printed program, and that their authors shall be given the privilege of presenting them on the floor at the meeting. The program should also announce the names of those who have signified a desire to discuss a paper. The aim should be, in time, to have all papers preprinted.

Fifth.—It is recommended that the annual meeting be held during the third or fourth week in February instead of the first week, and that this Committee demand that copies, or at least abstracts, of all papers be in the hands of the Committee by February first, unless previously printed.

Sixth.—It is recommended that the succeeding Committee arrange for a session to be devoted to a symposium on tunnel, and other kilns; that the claims of the patentees be supported by data from actual users of the kilns; that all presentation be printed in advance and the data so presented be referred to a committee for report and recommendation to the Society.

This Committee desires to thank the individual members of the Society for their generous response at a crucial time. The chairman desires to express to all the members of the Committee his appreciation of their prompt and loyal support; to Mr. Barringer, Chairman of the Publication Committee, and to Secretary Binns, for their excellent team-work with this Committee; and especially to Professor Brown, Editor of the Journal, for his splendid coöperation and painstaking work, which has contributed so largely to making the Journal a success.

R. H. MINTON, *Chairman.*

Report of Summer Meeting, 1918

The chairman wishes to acknowledge the valued coöperation of his associates on the Committee, all of whom were present at the meeting, and particularly the services of Mr. C. D. Fraunfelter, who as treasurer of the Committee had charge of the large entertainment fund so generously donated by the clay manufacturers of Zanesville, Roseville, and Crooksville.

The meeting was declared to be an exceptional one in many ways. In point of registration and average attendance at meetings it materially exceeded that of any former meeting. There were over ninety enrolled, about seventy-five of these coming from beyond the borders of the Zanesville district. The crowd held together well and gave many manifestations of appreciation and enjoyment of the program provided.

In this plant a number of the members had their first view of the Dressler tunnel kiln. One is used in bisque firing and another in glost. Another feature was the use of the Berg brick press adapted to the pressing of wall tile.

In the afternoon the first plant visited was that of the Brush McCoy Pottery Company where the President, George Brush, showed the processes involved in casting and jiggering pottery specialties. He also presented each member with a busy bee souvenir. At the J. B. Owens Tile Company the structural beginnings of an Owens' tunnel kiln were observed. The party was then conducted through the Ohio Pottery Company by the president, C. D. Fraunfelter, and the Plant Superintendent, John Herold. This is one of the few plants in the country producing chemical porcelain.

In the evening the get-together meeting consisted of a banquet in the dining room of the Hotel Rogge.

On Wednesday morning, the party left the hotel at nine for the Roseville Pottery Company, where G. F. Young, president of the company and Russell Young, plant superintendent, extended the courtesies of the plant. Here was witnessed the operation of the tunnel kiln in the production of art pottery and cooking ware. The members then proceeded to the plant of the American Encaustic Tiling Company. Here the members displayed particular interest in clay storage bins and trolley system, use of

compressed air to secure pressure in slip presses, specially designed tile presses, and tunnel kilns for maturing of glazed ware.

In the afternoon, the Society enjoyed an excursion down the Muskingum on the Steamer Louise. During the return trip a chicken dinner was served. Zanesville's well-known entertainer, Charles Lauck, sang a number of songs including one entitled "The Ceramic Jubilee." Items of business transacted at the dining table were ratification of the action of the Board of Trustees in amending the Society rules to conform with postal regulations, and on motion, the appointment of a committee to recommend by resolutions action to be taken with reference to the communication from A. F. Greaves-Walker in regard to the work of the Fuel Administration. The expenses of the excursion were met from the entertainment fund. Arriving at Zanesville at seven-thirty the party proceeded to the plant of the Kearns Gorsuch Company where great interest was manifested in the process of glass-making and automatic bottle-blowing.

On Thursday morning the members were met at the hotel by L. K. Brown, Secretary-Treasurer of the Burton Townsend Company, who conducted them to the large paving brick plants of this company. A modern, molding sand mill was also observed here.

In the afternoon, the Ceramists ensconced themselves in autos donated by members and friends, and motored west on the National Highway to the flint ridge district. Wilbur Stout of the Ohio State Geological Survey explained the ancient quarry workings where the moundbuilders and later the American Indian carried on extensive operations. At another point the scene of an ancient workshop was visited where implements were wont to be formed from the flint. After inspecting the moundbuilders' fortifications at the Golf Grounds, Newark, Ohio, the party proceeded to the Buckeye Lake Resort. A shore dinner was ready for the members upon their arrival at the resort hotel. After indulging in the various amusements offered, the party returned by autos at a late hour.

The last day of the meeting was spent in visiting a variety of industries in adjacent towns. The first stop was at Ransbottom Brothers Plant in Roseville. The capacity of this plant is ten carloads of ware a day. Modern jar machines and other stone

ware equipment in operation were explained. The next stop was at the plant of the Crooksville China Company at Crooksville. An item of interest here was a rotary drier which had replaced the mold carrier, an old style pottery drier. The autos again conveyed the party to the local hotel where a chicken dinner was served at the expense of the Crooksville China Company and the A. E. Hull Pottery Company.

After dinner the every-ready autos afforded conveyance to the plant of the A. E. Hull Pottery Company. Here the visitors were greeted by the genial countenance of A. E. Hull, president of the company, who demonstrated the methods of manufacturing white table ware by single fire process. A unique method of slip decoration was also a feature.

About one o'clock the party boarded the Pennsylvania train for New Lexington. The Ludowici Celadon Company operates a private street car line to the depot, and the Superintendent, Samuel Frew, was ready for the crowd with the special street car to convey the members to the plant. The operation of the shale planer, cutting a sixty foot face of shale, was a marvel to most of the members. Methods of raw clay storage preparation and feeding were exceptionally efficient. The producer gas-fired continuous chamber kiln was explained by Mr. Frew. The method of glazing and firing glazed roofing tiles, was also of special interest.

The last plant visited was that of the Ohio Brick and Stone Company. The party was met by Mr. C. B. Young, General Manager, and conveyed in the company autos to the mine where an extensive vein of flint fire clay is mined, with the use of regular coal mining machines. The clay is then passed through a washing plant to free it from iron impurities that occur in soft seams in the flint clay strata. In forming the brick, a portion of the flint clay is ground in a wet pan and this is used as a bond in forming the brick by the dust pressed process.

After inspecting these operations, the members for the most part boarded trains for their various home destinations. A number, however, returned to Zanesville where one morere union was held before the last words of good will and good luck were exchanged.

F. K. PENCE, *Chairman.*

OFFICERS, 1919–1920

President

Ray T. Stull ..... Columbus, Ohio

Vice-President

R. H. Minton ..... Metuchen, N. J.

Secretary

Charles F. Binns ..... Alfred, N. Y.

Treasurer

R. K. Hursh ..... Urbana, Ill.

Trustees

The four above-named officers and

Earl T. Montgomery, term expires 1920.
R. D. Landrum, term expires 1921.
M. F. Beecher, term expires 1922.
George H. Brown, Past President.
H. F. Staley, Past President.

EX-PRESIDENTS AND WHERE MEETINGS HAVE BEEN HELD

Herbert A. Wheeler	1899–1900	Columbus, Ohio
Karl Langenbeck	1900–1901	Detroit, Mich.
Charles F. Binns	1901–1902	Old Point Comfort, Va.
Ernest Mayer	1902–1903	Cleveland, Ohio.
Edward C. Stover	1903–1904	Boston, Mass
Francis W. Walker	1904–1905	Cincinnati, Ohio
William D. Gates	1905–1906	Birmingham, Ala.
Willard D. Richardson	1906–1907	Philadelphia, Pa.
Stanley G. Burt	1907–1908	St. Louis, Mo.
Albert V. Bleininger	1908–1909	Columbus, Ohio
Ross C. Purdy	1909–1910	Pittsburgh, Pa.
H. Ries	1910–1911	Trenton, N. J.
Charles Weelans	1911–1912	Chicago, Ill.
Arthur S. Watts	1912–1913	Washington, D. C.
Ellis Lovejoy	1913–1914	Wheeling, W. Va.
Cullen W. Parmelee	1914–1915	Detroit, Mich.
Richard R. Hice	1915–1916	Cleveland, Ohio
Lawrence E. Barringer	1916–1917	New York, N. Y.
George H. Brown	1917–1918	Indianapolis, Ind.
Homer F. Staley	1918–1919	Pittsburgh, Pa

OFFICERS OF INDUSTRIAL DIVISIONS, 1919–1920

Glass Division

C. H. Kerr, *Chairman* — E. W. Tillotson, *Secretary*

Enamel Division

J. W. Sanders, *Chairman* — R. R. Danielson, *Secretary*

Terra Cotta Division

F. B. Ortman, *Chairman* — R. L. Clare, *Secretary*

White Ware and Porcelain Division

C. L. Sebring, *Chairman* — Chas. F. Goodwin, *Secretary*

Refractories Division

A. V. Bleininger, *Chairman* — R. M. Howe, *Secretary*

Brick and Tile Division

Marion W. Blair, *Chairman* — W. W. Ittner, *Secretary*

Wall and Floor Tile Division

F. K. Pence, *Chairman* — F. W. Walker, Jr., *Secretary*

OFFICERS OF LOCAL SECTIONS, 1919–1920

Pittsburgh District Section

R. R. Hice, *Chairman* — F. H. Riddle, *Secretary*
F. W. Walker, Sr., *Councilor*

Northern Ohio Section

E. P. Poste, *Chairman* — Bryan A. Rice, *Secretary*
R. D. Landrum, *Councilor*

St. Louis Section

Chas. W. Berry, *Chairman* — Gail R. Truman, *Secretary*
D. T. Farnham, *Councilor*

New England Section

W. H. Grueby, *Chairman* — C. J. Hudson, *Secretary*
C. H. Kerr, *Councilor*

Central Ohio Section

F. K. Pence, *Chairman* — J. D. Whitmer, *Secretary*
A. S. Watts, *Councilor*

Chicago Section

I. E. Hardy, *Chairman* — H. T. Bellamy, *Secretary*
C. W. Parmelee, *Councilor*

New York State Section

S. C. Linbarger, *Chairman* J. B. Shaw, *Secretary*
L. E. Barringer, *Councilor*

Eastern Section

Chas. H. Cook, *Chairman* G. H. Brown, *Secretary*
Chas. A. Bloomfield, *Councilor*

STANDING COMMITTEES, 1919–1920

Committee on Publications

L. E. Barringer, *Chairman*
G. H. Brown, *Editor*
H. Ries
A. V. Bleininger
E. W. Tillotson

Committee on Research and Development

A. V. Bleininger, *Chairman*
L. E. Barringer
A. S. Watts
C. H. Kerr
C. F. Binns
E. W. Washburn
R. T. Stull
H. F. Staley

Committee on Membership

F. H. Riddle, *Chairman*
R. D. Landrum
R. L. Clare
F. B. Ortman
R. D. Hatton
F. K. Pence
J. B. Shaw
T. H. Sant

Committee on Standards

M. F. Beecher, *Chairman*
J. B. Shaw
E. P. Poste
E. E. F. Creighton
C. W. Berry
F. H. Riddle
R. M. Howe
H. Wilson
R. K. Hursh
F. A. Kirkpatrick
C. B. Harrop
E. C. Hill
M. C. Booze
I. A. Williams

Committee on Coöperation

C. H. Kerr, *Chairman*
G. E. Barton
W. E. Emley
W. D. Gates
E. Hart
F. R. Henry
D. F. Riess
K. Seaver
C. L. Sebring
F. W. Walker, Sr.
A. F. Greaves-Walker

Committee on Rules

C. W. Parmelee, *Chairman*
A. S. Watts
S. G. Burt
A. F. Greaves-Walker
Ellis Lovejoy

Committee on Sections and Divisions

R. R. Hice, *Chairman*
W. D. Gates
M. E. Gregory
F. K. Pence
H. A. Wheeler

Committee on Papers and Programs

R. H. Minton, *Chairman*
Chas. F. Binns
John W. Sanders
F. B. Ortman
C. L. Sebring
A. V. Bleininger
C. H. Kerr
M. W. Blair
F. K. Pence
F. H. Riddle
Gail R. Truman
C. J. Hudson
J. D. Whitmer
J. B. Shaw
G. H. Brown
H. T. Bellamy

SPECIAL COMMITTEES

Summer Meeting, 1919

Buffalo

S. C. Linbarger, *Chairman*
W. J. Rea
R. H. White
Herman Worsham
F. J. Tone

Cleveland

R. D. Landrum, *Chairman*
O. C. McCormick
Wm. M. Clark
A. S. Walden
E. P. Poste
L. J. Frost

Definition of "Ceramic"

E. W. Washburn, *Chairman*

A. L. Day
H. Ries

REPORT OF THE BOARD OF TRUSTEES, 1919–1920

The Board of Trustees finds much satisfaction in being able to report a successful year. In certain aspects the past year has been the best in the history of the Society. A considerable increase in membership, a substantial addition to the funds, life and activity on the part of sections and divisions, and recognition among the important scientific and engineering organizations of the country are all evidence of progress and useful work. The activities centering in the office of the secretary have been more strenuous than ever before. Nearly fourteen thousand pieces of mail have been sent out and over three thousand received. The cash remitted to the treasurer has averaged over $1500 monthly. The expense of administration has of course increased but not in undue proportion. The Journal has been printed

and mailed, salaries and expenses have been paid, and there is shown a balance of 28 per cent of the entire receipts.

In addition to the several meetings held at Pittsburgh, in February, the Board met at Buffalo on the occasion of the summer meeting when important business was transacted. Of necessity, however, the greater part of the work of the Board has been carried on by mail and wire. Thirty-two motions have been made and passed by correspondence and particulars of these actions have been duly published in the Journal.

The Standing Committees have continued their useful work, but as each will render its own report, detailed mention will not be made here. The Board, however, on behalf of the Society, tenders a full measure of thanks to the chairmen and members of these committees who often at personal sacrifice have devoted themselves without stint to the service of the Society and of the members at large.

Of the industrial divisions mentioned last year, four, Enamels, Glass, Refractories, and Terra Cotta, have rendered a good account of themselves. To each of these divisions has been allotted a portion of the program and a separate room for discussion. The remaining suggested divisions, Abrasives, Brick and Tile, Floor and Wall Tile, and White Wares, have not as yet been fully organized, but plans are in process of development which it is believed will materialize during the present year.

The program presented for discussion at the present meeting is by far the largest ever set before the Society. 139 papers are announced. This has been made possible by the work of the divisions and has, of course, necessitated the divisional meetings which are projected. Without this segregation the program would be of an impossible length for a three-day session.

The Society was again represented at the Chemical Exposition, which was held in Chicago in September. A general ceramic session was held at which papers were read and motion pictures shown. A dinner was arranged at the New Southern Hotel, at which 62 members were present.

The membership list is in a satisfactory condition. While there has been a loss by death or resignation of only 37 members, there has been an increase of 237, including 21 Corporation Members.

For the first time in its history the Society has benefitted from income from investments. The funds invested last year have brought in $160.90 as interest. The policy of laying something by for future contingencies will be continued.

In the matter of the present convention, a new departure has been made in the organization of a strong local committee. This step was necessary in view of the enlarged scope of the meeting and the necessity of arranging numerous local details. The Board takes this opportunity of placing on record their thanks to this Committee and their appreciation of the excellent work accomplished.

FINANCIAL STATEMENT

YEAR ENDING DECEMBER 31, 1919

RECEIPTS

Brought forward, Jan. 30, 1919	$ 1,801.17
Dues and fees, Active and Associate	7,189.59
Corporation dues	2,075.00
Volumes sold	1,164.74
Journal subscriptions	1,031.35
Journal advertisements	5,439.04
Reprints	283.24
Seger's "Collected Writings"	82.50
Branner's "Bibliography of Clays"	2.00
Refund from Chemical Exposition, 1918	42.10
"Directory of Dealers"	7.00
Interest on Liberty Bonds	124.35
Interest on Treasury Certificates	36.55
Miscellaneous	36.03
	$19,314.66

DISBURSEMENTS

Salaries	$ 3,113.33
Publishing 14 numbers of Journal	6,015.27
Reprints and Abstracts	638.98
Expenses of Annual Meeting 1919	283.75
Badges	210.00
Compilation of Index to Transactions	456.30
Insurance and storage of volumes	101.35
Binding and purchase of volumes	255.00
Office equipment	251.42
Office expense, Secretary, Editor, President, and Treasurer	1,134.35
Traveling expenses	224.14
Chemical Exposition, 1919	63.37
Seger's "Collected Writings"	68.60
Committee expense	120.37
Division expense	41.38
Dues, N. F. P. A.	30.00
Miscellaneous	44.75
	$13,052.36
Balance in checking account	1,262.30
Certificate of deposit	5,000.00
	$19,314.66

MEMBERSHIP

Brought forward, February 1, 1919:	
Honorary	4
Life	2
Corporation	77
Active, Resident	100
Active, Foreign	11
Associate, Resident	756
Associate, Foreign	75
	1025
Accessions During Year	
Corporation	21
Associate, Resident	200
Associate, Foreign	16
	237
Losses During Year	
Dropped, Honorary (Deutsche Verein)	1
By death,	
Associate, Resident	4
Associate, Foreign	4
By resignation,	
Corporation	4
Active, Resident	1
Associate, Resident	20
Associate, Foreign	1
	35
Transferred from Associate to Active Membership	
Resident	88
Foreign	3
	91
Status, February 9, 1920	
Honorary	3
Life	2
Corporation	94
Active, Resident	187
Active, Foreign	14
Associate, Resident	844
Associate, Foreign	83
	1227

CHAS. F. BINNS, *Secretary*

REPORTS OF DIVISIONS, 1919–1920

Glass Division

The Glass Division held its first meeting on February 3 and 4, 1919, during the Annual Meeting at Pittsburgh. C. H. Kerr was elected chairman and E. W. Tillotson secretary of the Division for 1919–20.

At that time the membership of the Division was approximately 100, of whom about half were present at one or the other of the two first meetings.

At the time of the summer session a meeting of the Glass Division was held in Cleveland, August 7, 1919, with twenty members present, and about the same number of members in the Pittsburgh District gathered on October 2, 1919, to meet Dr. W. E. S. Turner, Secretary of the Society of Glass Technology, Dr. Morris Travers and Mr. J. Connolly. An invitation has been extended to the Society of Glass Technology to meet with the Glass Division during the summer of 1920 and has been accepted by the Society.

Eight letters have been sent out to the membership of the Division during the year.

For the purpose of such committee work as might be necessary and to perform the duties of the councilors a "Central Committee" was appointed consisting of: William M. Clark, *Chairman*, R. L. Frink, C. O. Grafton, J. C. Hostetter, F. A. Kirkpatrick, S. R. Scholes, E. W. Washburn. These gentlemen are to hold office until the next annual meeting of the Society.

At the present time the Division numbers 159, of whom 18 are foreign members. This increase in membership is an expression of the interest which exists in the field of glass and is indicative of the opportunity presented to the Society in this important field of ceramics.

E. W. Tillotson, *Secretary.*

Refractories Division

A very keen interest was exhibited at the Annual Meeting in Pittsburgh and plans for the establishment of a Refractories Division were completed. Sufficient progress was made by July to call a

second meeting, which was held in Buffalo on August 4th. This meeting was particularly well attended and a lively discussion obtained. A dozen problems were suggested, seven papers were promised for the twenty-second annual meeting, and the subject of a question box was discussed. It appeared desirable to establish sub-committees on micro-structure and on glass house refractories, and these committees are now at work. The 100 members of the section are reached through the medium of bi-monthly letters.

RAYMOND M. HOWE, *Secretary.*

Terra Cotta Division

This Division was formed at the last meeting of the Society in February, 1919, and has finished its first year with fifty members, representing all except one of the terra cotta companies in the country.

Efforts were made early in the year to get each company started on some line of original research, and we were successful in having eleven investigations started most of which will be presented at this meeting.

The National Terra Cotta Society has also taken an active interest in the work of the Division. They have appointed a committee to report on ways and means of coöperating with us and of fostering intelligent research work along terra cotta lines. This committee reports at their meeting now being held in San Francisco, and we look forward to some very active assistance from them during the coming year.

R. L. CLARE, *Secretary.*

Enamel Division

The Enamel Division was organized in accordance with plans of the Society for industrial divisions, at the annual meeting in Pittsburgh, February 3, 1919. Thirty members of the parent society gathered at that time and elected a chairman and secretary.

The enrollment accredited to the Division, as reported by Secretary Binns on March 15, 1919, was as follows: active members 11, associate members 46, corporation members 5, total 62.

The enrollment on February 15, 1920, was as follows: active members 10, associate members 63, corporation members 8, total 81. During this period one active and three associate members have been dropped from our roll because of resignation from the Society. The Division has also lost two members through death.

During the year there has been sent out from the office of the secretary three circular letters to all members of the Division and one from the chairman's office. These have served: (1) to acquaint the members with the formation of the Division; (2) to present to them for their approval a set of by-laws; (3) to call their attention to the necessity for active coöperation in the presentation of papers, and (4) to urge upon them the wisdom of attending this meeting of the Society and Division.

The entire enameling industry has been thoroughly canvassed in a drive for members, by personal letters from the secretary and self-appointed membership committees in the Division, with the result that our membership has shown an increase of about thirty per cent. No differentiation was made between members and non-members in the recent notices of this meeting, invitations being mailed to every one known to be interested in the enameling industry.

The efforts of the Division officers coupled with the splendid coöperation of the Division members has resulted in the presentation of ten papers at this meeting, a larger number than heretofore presented on enamels at any one meeting. Further data are now being gathered by several members which will result in future papers, sufficient we believe to give us a paper in each number of the Journal if the space will permit.

During the past year arrangements have been made to supply the Journal with abstracts of articles on enameling and allied processes. While literature on enamels is limited, a start has been made, and with the abundance of original papers, the Journal of the American Ceramic Society will contain in each issue something of interest to enamelers.

While the past year has been highly successful and has thoroughly demonstrated the advisability of the idea of industrial divisions, at least as applied to the enameling industry, we look

forward to an even more successful year with the enrollment of every enameler in the American Ceramic Society and this Division by the date of the next annual meeting.

R. R. DANIELSON, *Secretary.*

REPORTS OF LOCAL SECTIONS, 1919–1920

Northern Ohio Section

Meeting of April 28, 1919, Portage Hotel, Akron, Ohio. Inspection trips through the plants of The Goodyear Rubber Co., and The Robinson Clay Products Co., plant No. 1, followed by business session and presentation of the following papers:

"Glaze Studies," Hewitt Wilson, Ohio State University.

"The Present Trend in Porcelain Manufacture," E. T. Montgomery, Jeffery-Dewitt Co., Detroit.

"Utility and Art in Brick Construction," Wm. P. Blair, Secretary, National Paving Brick Manufacturing Association.

Illustrated talk on "Enamel Manufacture," E. P. Poste, Elyria Enameled Products Co.

Meeting of June 23, 1919, Willoughbeach Park, Cleveland, Ohio.

"Symposium on Fuels, Producer Gas and Fuel Oil," Mr. Ward, The General Combustion Co., Chicago, Ill.

Meeting of December 1, 1919, Hotel Cleveland, Cleveland, Ohio.

Election and installation of officers.

"Testing of Fire Brick," A. F. Gorton, Toledo, Ohio.

Discussion of cements and refractories, led by Ross C. Purdy, of Buffalo, N. Y.

Attendance at all meetings was good and the Section is in a flourishing condition.

CHARLES H. STONE, JR., *Secretary.*

St. Louis Section

At the annual meeting of the St. Louis Section of the Society held at the American Hotel on February 11th, the retiring officers, Mr. C. W. Berry, *Chairman*, and Mr. D. T. Farnham, *Councilor*, were replaced by I. A. Krusen as Chairman and C. W. Berry as Councilor. Gail R. Truman was re-elected Secretary-Treasurer.

Fifteen men were present, four active members, six associate

members, four local members and one guest. After dinner a most interesting program was given as follows: "Glass Melting Pots," C. W. Berry; "Manufacture and Use of Electrical Porcelain," I. A. Krusen; "Manufacture of Architectural Terra Cotta," G. R. Truman; "Artificial Sillimanite," A. Malinovzky.

The name "St. Louis Section" was formally adopted to designate the local chapter, which at present draws its members from that territory known as "The Southwest." The by-laws adopted by the New York State Section, with a couple of alterations, were approved for local use.

GAIL R. TRUMAN, *Secretary.*

New England Section

While the New England District includes some very important ceramic enterprises it is nevertheless a district which is numerically small in ceramic population. What the district lacks, however, in numbers, it makes up in enthusiasm. The members of the New England Section feel confident that no other Section of the Society shows as great per capita membership or activity as we have here in New England. The Section has about 40 members all of whom are very much interested in the success of the Section.

During the past year it has been possible to hold only two general meetings. The first meeting was held at the Boston City Club in Boston on October 25 with Mr. W. H. Grueby in the chair. There were 12 members present. The chief item on the program was a talk by Mr. L. E. Barringer, of the General Electric Company, Schenectady, N. Y., on "Some Problems in the Manufacture of Electrical Porcelain." The paper was followed by a very lively and interesting discussion.

On January 31, 1920, a meeting was held at the Boston City Club. Mr. W. H. Grueby was in the chair and 28 members were present. The chief papers were:

"The Pyrometer and its Value in Kiln Firing," by E. G. Chaffin, of the Norton Co., Worcester, Mass.

"The Manufacture of Graphite Crucibles," by M. C. Booze, of the Norton Co., Worcester, Mass.

At the meeting of January 31, 1920, officers for the ensuing year were elected: C. J. Hudson, *Chairman;* M. C. Booze, *Secre-*

tary-Treasurer; M. F. Beecher, *Councilor,* all of the Norton Company, Worcester, Mass. The Executive Committee for the ensuing year consists of the above officers and the two following men: O. C. Dusossoit, Taylor Instrument Co., Boston, Mass., George A. Henderson, Dorchester Pottery Works, Dorchester, Mass. The Treasurer's report presented at the January 31st meeting showed a balance of $25.52 on hand.

The New England Section is in a most flourishing condition. The plans for the coming year insure a steady and profitable growth.

C. H. KERR, *Councilor.*

Central Ohio Section

The first meeting after the 1919 convention of the American Ceramic Society was held at Zanesville on April 25. Mr. Larsen, of the Chemical Warfare Service, gave a résumé of the "Development of Activation of Charcoal for Gas Masks." This was interesting as the highest known activation was secured by the development of the tunnel kiln. Mr. R. L. Frink, of Lancaster, gave a very interesting talk on "Pyrometers." Professor A. S. Watts gave a talk on the "Raw Materials Used in Ceramic Industries."

The next meeting was held at Lord Hall, O. S. U., Columbus, O., on November 8, 1919, in connection with the Student Branch of the Society located at Ohio State University. The meeting was addressed by Colonel Edward Orton, Jr., his subject being "The Various Types of the Human Equation." Professor C. B. Harrop gave a very instructive talk on "The Open Fire *versus* the Muffle Type of Tunnel Kilns."

The next meeting was held on February 18, 1920, at the Hotel Deshler, Columbus, O., in connection with the meeting of the National Brick Manufacturers Association. The following papers were presented: "A Glaze Study Involving Some Interesting Colors Developed by Nickel Oxide," by J. D. Whitmer; "Essentials for Training Ceramic Engineers," by R. C. Purdy.

At an adjourned meeting held the same evening the following officers were elected: M. B. Cheney, *Chairman;* J. D. Whitmer, *Secretary-Treasurer;* A. S. Watts, *Councilor.* The financial

statement presented at this meeting showed a balance of $56.82 in the treasury.

Respectfully submitted,
ARTHUR S. WATTS, *Councilor.*

Chicago Section

The sixth meeting of the Section was held in connection with the Forty-first Annual Convention of the Illinois Clay Manufacturers Association at the LaSalle Hotel, Chicago, on April 9, 1919. The program included a dinner after which the following papers were presented: "Discussion of the Humidity System of Drying Clay Wares," by B. S. Radcliffe, Midland Terra Cotta Co., Chicago; "Heat Insulation for Industrial Furnaces," by H. N. Haberstroh, Celite Products Co., Chicago; "Notes on Zirconium," by E. E. Libman, University of Illinois, Urbana. All of these papers were of much interest and were freely discussed. There were about forty present and after the papers, the members were favored by some informal remarks by Mr. W. D. Gates and Dr. Mars.

At the same meeting, upon the invitation of the University of Illinois, the following men were nominated as representatives of the Chicago Section to serve on the Advisory Board of the Ceramic Department: E. F. Achardt, General Manager, Federal Plate Glass Co., Ottawa, Illinois; Chas. S. Reed, President, Chicago Retort and Fire Brick Co., Ottawa, Ill.; Theo. G. Dickinson, President, Marquette Cement Co., Chicago; F. H. Fall, Jr., Benjamin Electric Co., Chicago.

On Wednesday, September 24, "Ceramic Day" at the Chemical Exposition, the program was in charge of a committee of the Section, namely: W. D. Gates, Fritz Wagner, Jr., F. B. Ortman, B. S. Radcliffe, and H. T. Bellamy. A report has already been made on this meeting, and it will be sufficient to say that, notwithstanding some unfortunate circumstances with respect to the meeting place, the affair passed off satisfactorily and the attendance was excellent. The dinner in the evening was very successful.

The seventh regular meeting of the Chicago Section was held at the City Club, Chicago, on Saturday, November 29, 1919.

The following papers were presented: "Phosphate Cement," by R. K. Hursh, Urbana, Illinois; "Notes on Silica Brick," by G. E. Sladek, Urbana, Illinois. As is customary these papers followed a luncheon. The attendance was about eighteen. At this meeting officers were elected for the ensuing year. Mr. B. T. Sweely, Western Electric Co., Chicago, was appointed chairman of program committee and Mr. E. A. Brockman, Roessler & Hasslacher Chemical Co., Chicago, chairman of the membership committee.

C. W. PARMELEE, *Councilor.*

Pittsburgh District Section

The first meeting was held on April 23, 1919, at the Potters' Club, East Liverpool, Ohio. Mr. Bleininger gave a talk on the aims of the American Ceramic Society. Further appropriate remarks were made by Mr. Thomas Sant. Mr. Newells, Homer Laughlin China Co., gave an interesting talk on cost accounting in pottery manufacture.

The final meeting was held at the Mellon Institute on December 30, 1919. The following officers were duly elected: C. R. Peregrine, *Chairman;* J. Spotts McDowell, *Vice-Chairman;* L. R. Office, *Secretary;* Thomas H. Sant, *Treasurer;* F. W. Walker, *Councilor.*

The following very instructive papers were read: "Notes on Glass Refractories," A. V. Bleininger, U. S. Bureau of Standards; "Notes on Clay Pits of England," Thomas H. Sant, John Sant and Sons Co., E. Liverpool, Ohio; "Refractory Cements," R. M. Howe, Mellon Institute; "A Lining of Glass Pots," S. R. Scholes, H. C. Fry Glass Co., Beaver, Pa.; "Refractories for the By-Product Coke Plant," L. R. Office, Mellon Institute.

J. C. VOGT, *Secretary.*

New York State Section

The New York State Section held two meetings during the year, the first at Syracuse, May 9th and 10th and the second at Alfred, December 15th to 17th. There were fourteen members present at the Syracuse meeting and seventeen at the Alfred meeting. The present officers, elected at the May meeting, are:

S. C. Linbarger, *Chairman;* J. B. Shaw, *Secretary-Treasurer;* L. E. Barringer, *Councilor.*

The Section is planning increased activities during 1920. The treasury is amply supplied and the general outlook is satisfactory.

L. E. BARRINGER, *Councilor.*

REPORTS OF STUDENT BRANCHES, 1919–1920

Ohio State University Student Branch

The Student Branch held its annual dinner and reception on May 9, 1919, at Lord Hall, at which time we had addresses by R. T. Stull, President of the American Ceramic Society; Professor D. J. Demorest, Department of Metallurgy; W. J. McCaughey, Department of Mineralogy; and Professors Harrop, Wilson and Watts of the Department of Ceramic Engineering.

On October 28, 1919, the Society met and organized for the year. On November 8, 1919, we met with the Central Ohio Section of the American Ceramic Society and listened to talks by Colonel Orton, Professor Harrop and Professor Watts.

On November 18, 1919, the Society was addressed by Dr. James R. Withrow, Department of Chemical Engineering, on "The Requirements which Chemical Stoneware Must Meet."

The University buildings were closed on account of fuel shortage shortly after this, and it was impossible to hold further meetings. The Society, however, met in January and had its picture taken for display in the Department and for insertion in the College Annual.

On February 18, 1920, we met with the Central Ohio Section at the Deshler Hotel, Columbus, O., and listened to addresses by J. D. Whitmer and R. C. Purdy.

The Student Branch consists at present of thirty-seven members.

The officers are as follows: J. S. Gregorius, *Chairman;* W. E. Cramer, *Vice-Chairman;* J. L. Carruthers, *Secretary-Treasurer.*

Respectfully submitted,

ARTHUR S. WATTS, *Councilor.*

University of Illinois Student Branch

The first meeting of the year was held early in October. It was well attended and a lively interest in the organization was evi-

dent. It was decided to hold monthly meetings and to make up the programs, to a large extent, of papers by the members themselves. This has been well carried out, and some interesting talks have been given by a number of the students on plant experience or descriptive of plants visited. The meetings have been fairly well attended and some lively discussions have taken place. At one of the meetings Prof. S. W. Parr talked on the subject, "Sulfur in Coal," discussing the modes of its occurrence and its effect on the burning properties.

It is hoped that some week-end trips to near-by ceramic plants may be arranged to stimulate greater interest among the younger students and to provide material for further discussions in the meetings.

The paid-up membership is twenty-four. The officers for the current year are:

First Semester, *Chairman*, Gordon Klein; *Secretary*, Marshall W. Harris; second semester, *Chairman*, Gordon Klein; *Secretary*, William W. Coates, Jr.

R. K. HURSH, *Councilor*.

New York State Student Branch

The New York State Students' Branch has held regular meetings twice a month except when interrupted by vacations. At the first meeting George Ford was elected president and J. Clair Peck, secretary. Professor Binns spoke upon the work of the American Ceramic Society and the aims of the Student Branch.

It was decided to divide the first and second year men each into two groups and to organize a contest to be carried out at the next following meeting. Each group was to formulate two questions dealing with ceramic subjects, one question to be given in writing one week before the meeting; the other to be propounded on the floor and to be answered without previous consideration. The Meetings so arranged were very successful, the attendances were large and much interest was shown.

A number of the members attended the annual meeting of the Society at Philadelphia and upon their return a joint meeting was arranged by the Department of Applied Art of the New York

State School, at which reports of the annual meeting were given by those who attended.

CHARLES F. BINNS, *Councilor.*

Iowa Student Branch

The Iowa Student Branch has been holding meetings regularly on Tuesday afternoons in the rooms of the Ceramic Engineering Department of the Iowa State College. The aim has been to allow the students to carry on the programs themselves as much as possible. Faculty members have been in attendance at all meetings and occasionally have given regular talks but as a rule have confined themselves to discussion of the reports by students.

At the first of the school year, in September, the following officers were elected: *Chairman*, Mr. J. W. Whittemore; *Secretary-Treasurer*, Mr. H. E. Borg; *Program Committee*, J. W. Whittemore and L. R. Alt; *Social Committee*, H. E. Borg and F. W. Greenlee. Prof. O. J. Whittemore was appointed Councilor by the Board of Trustees of the Society.

The following subjects have been discussed to date:

"Purpose of the Student Branch of A. C. S.," Prof. O. J. Whittemore.

"Clays of Iowa and their Uses," Prof. S. L. Galpin.

"Obtaining Clay Samples," J. W. Whittemore.

"Chemical Stoneware and Glassware in the U. S.," J. W. Whittemore.

"Prospecting and Exploitation of Clay Deposits for Crude Clay Products," Prof. O. J. Whittemore.

"Tests of Clay Drain Tile and Sewer Pipe," W. J. Schlick of Engineering Experiment Station.

"Interesting Details of Operation of Sioux City Brick and Tile Co.," L. R. Alt.

"Construction, Operation and Advantages of Several Types of Clay Working Machinery," H. E. Borg.

"Operation of a Drain Tile Plant in Mason City, Ia.," J. W. Whittemore.

For the past two years this branch has been dormant, as the war very nearly stripped the college of Ceramic Engineering students. At present there is a membership of seven and the

outlook is for a large increase of enrollment. Even with the small number of members, the meetings have been carried on with much interest, and the students seem to be realizing considerable benefit through their association.

O. J. WHITTEMORE, *Councilor.*

REPORTS OF COMMITTEES, 1919–1920

Committee on Publications

The committee for the preceding year was reappointed by President Stull for 1919–1920.

The most important work of the Committee for the year consisted of the preparation of an index for the nineteen volumes of the Transactions and the addition of a section of abstracts to the Journal.

Late in 1919 Editor Geo. H. Brown resigned under pressure of other duties and the Board of Trustees appointed Mr. Homer F. Staley as his successor.

A new printing agreement was made with the Eschenbach Printing Co., at an increased cost due to the increasing costs of labor and material.

The Journal has not yet been established upon the regularity of monthly issue, but this condition will be reached early in the publication of Volume III.

The Society's membership should assist to the greatest possible extent in meeting the increased cost of publication by securing additional advertisers and subscribers.

A financial statement covering Volume II (1919) of the Journal is given below, together with a statement for Volume I (1918) for comparison:

EXPENDITURES

	Vol. I (1918)	Vol. II (1919)
Salaries, editor and assistant	$1,733.33	$1,953.33
Editor's office expense	123.33	353.87
Printing and distributing 12 numbers	4,283.00	5,737.23
Reprints	.....	431.45
Abstracts	.....	358.90
Total	$6,139.66	$8,834.78

Receipts		
From advertisers	$3,902.40	$4,678.24
Bills receivable	.....	372.00
From subscribers (non-members)	486.00	720.00
Total	$4,388.40	$5,770.24
Excess cost over revenue	$1,751.26	$3,064.54
	$6,139.66	$8,834.78

L. E. Barringer, *Chairman.*

Report of the Membership Committee

Unfortunately the membership campaign received a serious set back this year in the loss of its chairman, Mr. R. C. Purdy. Mr. Purdy resigned May 12th, and I was not appointed until just before accepting my present position in September. This change made it imperative that I do little outside work until I became familiar with the duties of my position. No active work was done on my part until October 1st. This meant five months lapse. However the individual members of the committee and the Division organizations have all been active.

The growth of the Society the last year as compared with the past three years is as follows:

	February 1st				Accessions during
	1917	1918	1919	1920	1920
Honorary	4	4	4	3	...
Life	...	1	2	2	...
Corporation	...	33	77	92	19
Active resident	71	79	100	187	88
Active foreign	5	9	11	14	3
Associate resident	414	568	756	841	196
Associate foreign	43	56	75	82	15
Total	537	750	1025	1221	321

There were 8 losses by death during the year and 125 by resignation. At the present time new members are joining at the rate of about twenty-five a month, and this gain will be increased considerably the latter part of the month during the convention.

Permit me to present the following suggestion for the consideration of the board:

It is apparent that the Divisions are going to be very active in securing new members. For this reason, and so that a Membership Committee could work in conjunction with the Divisions, I believe it would be worth while to have the Membership Committee composed of a chairman, interested in the membership committee primarily, and his committee made up of one member from each Division, also a couple of other members interested in lines which you think would eventually develop into Divisions. This combination will mean that the Divisions can be as active in membership work, as their member of the membership committee, and that they will not suffer if the chairman of the Membership Committee should happen to be uninterested. On the other hand, having a disinterested chairman will put him in a position to go after any members of his committee who are not showing enough activity in their particular Division. Each of the members could also act as chairman of the Membership Committee of the Division, if thought desirable. This whole system could go one step further and have members from the various Sections and Student Branches.

A special effort should be made to get more members who are interested in the manufacture of heavy clay products. This is the plan of the present committee and it is hoped that the plan will be pushed through. It is also possible to increase the membership and create a Division, if thought desirable, to approach those interested in arts and crafts, and pottery work in the schools. This is much more important than it would at first appear and should be considered. We are particularly fortunate in having members who can get in touch with such people.

F. H. RIDDLE, *Chairman.*

Committee on Standards

Your Committee has been engaged for the past two years in revising and amplifying the tentative methods presented at the Indianapolis meeting in 1918, and in starting the preparation of several additional tentative methods. This has involved a large amount of laboratory work as well as a large volume of correspondence, but even so our program outlined at Pittsburgh for 1919 has fallen far short of accomplishment. Instead of having

the revised methods in print at this time, we find there are still several months' work to be done. The present status of our work is as follows:

Six of the former tentative methods, after careful study through application in three laboratories, have been amended and revised and recommended to the Society for adoption as Standard. The ballot has already been distributed to the membership. These methods are: drying shrinkage, shrinkage and pore water, water of plasticity, true specific gravity, softening point, behavior in firing. Five other tentative methods have been studied in a similar manner resulting in certain amendments, but the Committee wishes to present these again as either tentative or optional. These are: fineness, ultimate chemical analysis, warpage, transverse strength, slaking. One new tentative method has been prepared and will be submitted for the first time under this classification. This is a method for the sampling of raw materials.

In addition we have in preparation an appendix to be presented in connection with the above material, which is designed to give general and specific suggestions to assist the operator in arranging his apparatus and carrying out the details of the methods to the best effect. We are also engaged in preparing a set of standard definitions for ceramic terms. This portion of our work is far from complete. A plan for the presentation of this material has been agreed upon and we hope it will be in print within the next few months.

At the suggestion of the Glass Division, the Committee is now giving consideration to the possibility of changing the rule governing the appointment of this Committee so that the standardization work pertaining to a given industry may be handled by a committee within the Division representing that industry. It would be advisable, of course, to have these divisional standardization committees so correlated with the Committee on Standards that duplication of work as well as conflicting methods may be avoided.

M. F. BEECHER, *Chairman.*

Committee on Coöperation

Herewith is submitted a brief report on the activities of this Committee during the past year.

National Exposition of Chemical Industries.—The chief work of the Committee during the year was in connection with representation of the Society at the Fifth National Exposition of Chemical Industries held at the Coliseum at Chicago during the week of September 22, 1919. Membership of this Committee included only one, Mr. W. D. Gates, who lives in the Chicago district and Mr. Gates was, therefore, called upon to arrange with the management of the Exposition for a booth to be used as the Society's headquarters. Mr. Gates also appointed a local committee in Chicago and this local committee together with the Chicago Section officially looked after the arrangements, so far as they pertained to matters in Chicago.

The management of the Exposition set aside Wednesday, September 24, as Ceramic Day and an excellent program was arranged. The program follows:

1. "The American Ceramic Society, Past, Present and Future," Prof. Charles F. Binns.
2. "Buy on Analysis," Dr. Alexander Silverman.
3. "Some Aspects of Scientific Research in Relation to the Glass Industry," Dr. E. W. Washburn.
4. "Superior Refractories," Mr. Ross C. Purdy.
5. "The Making of Pottery," Mr. Frederick H. Rhead.
6. "General Types of Optical Glass," Mr. Robert J. Montgomery.
7. "Brick and Tile," Mr. Douglas F. Stevens.
8. "The Application of Scientific Methods to Ceramic Research," Mr. A. V. Bleininger.
9. "The Manufacture of Optical Glass," Dr. J. C. Hostetter.
10. "Enameling Technology," Mr. R. R. Danielson.
11. "Fused Sillimanite Products," Mr. A. Malinovzsky.

Moving Pictures:

1. "Making of Cut Glass."
2. "Glass Bulb and Tubing Manufacture for Mazda Lamps."
3 "Manufacture of Architectural Terra Cotta."

In addition to the regular program we were very fortunate in having Dr. W. E. S. Turner and Dr. M. W. Travers from England, and our members appreciated very much the opportunity of becoming personally acquainted with these gentlemen.

As stated in the report of last year it was not found possible to segregate the ceramic exhibits, because the individual firms felt it was not advisable. After all, it is probably to the best interests of the Society to have ceramic exhibits scattered throughout the hall, because in this way more attention is actually drawn to the ceramic industries by the appearance of exhibits at intervals, and the casual visitor is certain to see some of the ceramic work whereas if it were segregated he might not visit that section at all.

It is the opinion of the Chairman of this Committee that it would be more advisable to have a special committee for this Exposition rather than to have such arrangements handled by any general committee. It is obvious that the nucleus of the Exposition Committee should be a resident in or near to the place of the Exposition and there is enough work in connection with this annual Exposition to justify the formation of a committee for the purpose.

Publicity Notices.—The publication of a regular monthly Journal by the Society has been of the greatest assistance to the Committee on Coöperation in securing publicity notices regarding the Society's activities. Other publications having a somewhat allied interest have been very free in their publication of notices of articles appearing in the *Journal of the American Ceramic Society* and even in reproducing such articles in abstract or in full, giving due credit to the Society.

Speakers.—It has been the desire of this Committee on Coöperation to arrange for speakers at various functions having in mind the propaganda work of the Society. Due to the unfortunate and prolonged illness of Dr. Hart who has had this matter in hand it has not been possible to accomplish a great deal, but it is believed that this does offer a fruitful field for creating increased interest in the Society.

Coöperation of other Societies.—One of the functions of the Committee is to furnish a proper channel of intercourse and coöpera-

tion through which relations with other scientific and technical Societies may be cleared. With Committees of the American Society for Testing Materials quite a little work has been done in achieving uniform standards of such testing methods as have been considered by both organizations. Similarly with the Society of Glass Technology plans have been established which undoubtedly will lead to close relations between the two Societies, in matters of mutual interest.

C. H. KERR, *Chairman.*

Committee on Sections and Divisions

On behalf of the Committee on Sections and Divisions, I beg to report there has been but little before the Committee during the past year. The only matter was the approval of by-laws of one of the Divisions. In this connection, we would urge that there be some action taken to make the rules or by-laws of the several Sections and of the several Divisions uniform. We realize there must be some difference, but these are very minor ones.

Nothing has been done during the year in regard to the drawing of lines between the territory properly belonging to the several Sections. RICHARD R. HICE, *Chairman.*

Committee on Papers and Programs

At our annual meeting in 1919 the Papers and Programs Committee in its final report made six recommendations for the consideration of the Board of Trustees and the succeeding committee. These were acted on favorably and the work of the committee has thus been greatly facilitated during the year.

The average membership from 1907 to 1917 was 426. From 1907 to 1919 only 240 members, or about 50 per cent, contributed all the papers published. This is equivalent to about 25 per cent of our present membership. Twenty members, Messrs. Bleininger, Watts, Purdy, Staley, G. H. Brown, Riddle, H. E. Ashley, E. T. Montgomery, Shaw, Orton, Schurecht, Emley, Pence, Stull, Parmelee, Minton, Binns, Simcoe, A. E. Williams and Kirkpatrick, slightly less than 5 per cent of the average membership from 1907 to 1917, and less than 2 per cent of the present

number, contributed 251 papers of the total of 631, or 40 per cent. Our most active contributors during this period were, Prof. Bleininger 29 papers, Prof. Watts 28, Prof. Purdy 23, Prof. Staley 21, Prof. Brown 17, Mr. Riddle 13, H. E. Ashley 12 and E. T. Montgomery 11.

It seems worth while to present a table for the twelve years 1907 to 1919 showing the membership each year, the number of papers published, the number of contributors and the percentage of contributors to the total membership.

T. A. C. S. Volume	Year	Membership	Papers	Contributors	Percentage
IX	1907	231	38	28	12%
X	1908	256	33	24	13
XI	1909	303	39	27	13
XII	1910	340	46	32	13
XIII	1911	381	50	32	13
XIV	1912	425	68	48	16
XV	1913	456	61	43	14
XVI	1914	466	57	41	12
XVII	1915	483	68	53	14
XVIII	1916	516	52	43	10
XIX	1917	537	44	35	8
Jour. Vol. I	1918	976	61	47	6
Jour. Vol. II	1919	1000	60	39	4

At our last annual meeting we had 60 papers on the program. This year we have 128, or more than double last year's program, and the list is not complete. Of these 128 papers 37 were published in the Journal during the past year, leaving 91 new papers. Besides these papers we have arranged for the session on tunnel kilns with at least seven contributors. It is evident, therefore, that the committee has put into operation its recommendations of last year. R. H. MINTON, *Chairman.*

Summer Meeting Committee

About fifty members assembled in Buffalo, August 4, 1919, for the Annual Summer Meeting of the Society. Owing to the very few representative ceramic industries in this district, the only ceramic plant visited was that of the Buffalo Pottery Company. Trips were taken through some of Buffalo's largest industries, including the Pierce Arrow Motor Car Company, The Larkin

Company and the Lackawanna Steel Company. One entire day was spent in a motor bus trip to Niagara Falls, which, besides including all the scenic points on both the American and Canadian sides of the River, afforded an opportunity to make an interesting inspection tour through one of the large plants of the Niagara Falls Power Company, and also a visit to the home of shredded wheat which was of special interest to the ladies present.

Wednesday night the party embarked on the good ship "City of Buffalo" and next morning found a large number of recruits at the pier in Cleveland. After breakfast at Cleveland's newest hotel, Cleveland Hotel, the party divided into four parts and were taken by automobile to visit the General Electric Company's glass works and their Nela Research Laboratories. The Enamel Products Company and The Cleveland Metal Products Company's enameling plant.

After a noon luncheon at the Hotel Cleveland, the entire party numbering more than 200, was entertained by the Northern Ohio Section at the Yacht Club. Water sports, in which Mr. Purdy had the leading rôle, and a baseball game, in which Dewitt F. Riess of Sheboygan covered himself with glory, were the principal events of the afternoon.

A complimentary dinner and smoker followed, and in the evening the summer meeting ended with a dance.

S. C. LINBARGER, *Chairman*, Buffalo.
R. D. LANDRUM, *Chairman*, Cleveland.

PUBLICATIONS OF THE AMERICAN CERAMIC SOCIETY

Annual transactions			Bound in cloth
Vol. I.	1899	110 pages	$4.75
Vol. II.	1900	278 pages	4.75
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Vol. V.	1903	420 pages	5.75
Vol. VI.	1904	278 pages	4.75
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Vol. VIII.	1906	411 pages	4.75
Vol. IX.	1907	808 pages	5.75
Vol. X.	1908	582 pages	5.75
Vol. XI.	1909	632 pages	6.25

Annual transactions			Bound in cloth
Vol. XII.	1910	882 pages	$6.25
Vol. XIII.	1911	837 pages	6.25
Vol. XIV.	1912	888 pages	6.25
Vol. XV.	1913	747 pages	6.25
Vol. XVI.	1914	611 pages	6.25
Vol. XVII.	1915	815 pages	6.25
Vol. XVIII.	1916	947 pages	6.25
Vol. XIX.	1917	707 pages	6.25
Journal			Unbound only
Vol. I.	1918	892 pages	6.00
Vol. II.	1919	1031 pages	6.00

To members of the Society a reduction of 40 per cent will be made from the above prices. Members cannot purchase more than one copy of each volume at member's rate.

NOTE: Vols. II, V, VIII, IX, X, XII, XIV, and XIX, will not be sold except in complete sets.

The Society has also published the following books, which will be sold net, at the prices listed, to the public and members alike:

The Collected Writings of Dr. Hermann August Seger, Volume I. (*a*) Treatises of a general scientific nature. (*b*) Essays relating to Brick and Terra Cotta, Earthenware and Stoneware, and Refractory Wares. 552 pages. Bound in cloth..... $7.50

The Collected Writings of Dr. Hermann August Seger, Volume II. (*a*) Essays on White Ware and Porcelain. (*b*) Travels, Letters and Polemics. (*c*) Uncompleted works and extracts from the archives of the Royal Factory. 605 pages. Bound in cloth.... 7.50

A Bibliography of Clays and the Ceramic Arts, by Dr. John C. Branner, 1906. 451 pages. Bound in cloth. Contains 6027 titles of works on Ceramic subjects..... 2.00

The above publications can be obtained of the Secretary and will be shipped at the consignee's expense by express or parcels post to any address on receipt of the price. To all who purchase a complete set of the Transactions, a copy of the Branner Bibliography is given free. Make all checks or money orders payable to The American Ceramic Society.

CHAS. F. BINNS, *Secretary.*
Alfred, N. Y.

Public Libraries where Publications of the American Ceramic Society May be Found

Boston Public Library.
Carnegie Library, Pittsburgh.
Cincinnati Public Library.
Cleveland Public Library.

Columbia University Library, New York City.
Cornell University Library, Ithaca.
John Crerar Library, Chicago.
Detroit Public Library.
Free Library of Philadelphia.
Grosvenor Public Library, Buffalo.
Iowa State College Library, Ames.
Johns Hopkins University Library, Baltimore.
Library of Congress, Washington.
Library of Emory University, Emory, Georgia.
Los Angeles Public Library.
Massachusetts Institute of Technology, Boston.
Mercantile Library of St. Louis.
New York Public Library.
New York State Library, Albany.
New York State School of Ceramics, Alfred.
Ohio State University, Columbus.
Providence Public Library.
Purdue University, LaFayette, Ind.
Syracuse Public Library.
St. Louis Public Library.
Trenton Free Public Library.
United States Geological Survey, Washington.
United States Patent Office, Washington.
University of California, Berkeley.
University of Colorado, Boulder.
University of Illinois, Urbana.
University of Iowa, Iowa City.
University of Michigan, Ann Arbor.
University of Minnesota, Minneapolis.
University of Texas, Austin.
University of Utah, Salt Lake City.
University of Washington, Seattle.
University of Wisconsin, Madison.
Worcester Free Public Library.

RULES OF THE SOCIETY

(Revised 1919)

I Objects

The objects of the American Ceramic Society are to develop the ceramic arts and the sciences related to the silicate industries by means of meetings for the reading and discussion of papers, the publication of scientific literature, and other activities.

II Membership

The Society shall consist of Honorary Members, Active Members, Associate Members, Affiliated Members, and Corporation Members.

Honorary Members must be persons of acknowledged professional eminence whom the Society wishes to honor in recognition of their achievements in ceramic science or art. Their number shall at no time exceed two per cent of the combined active and associate membership.

Honorary Members shall be nominated for election by at least five Active Members and approved by the Board of Trustees. Their nomination shall be placed before the Society at an annual meeting and to be elected they must receive the affirmative vote of at least ninety per cent of those voting, by letter ballot, at the next succeeding annual meeting.

Active Members must be persons competent to fill responsible positions in ceramics. Only Associate Members shall be eligible to election as Active Members and such election shall occur only in recognition of attainments or of services in the science, technology, or art of the silicate industries.

Associate Members must be persons interested in the silicate or allied industries.

The Board of Trustees shall in each regular meeting advance to Active Membership all Associate Members whose activity in the Society or whose prominence in the ceramic industries, in the opinion of a majority of the Board of Trustees, merits such recognition. Any Active Member may nominate in writing Associates for Active Membership and the Board of Trustees shall act on such recommendation at the next regular meeting of the Society. A written statement of the qualifications of each candidate shall be presented at that meeting of the Society and published promptly in the Journal.

Corporation Members must be persons, firms, or corporations who, being interested in the Society, make such financial contributions for its support as are prescribed in Section III.

Corporation members may be enrolled on the appropriate list of the Society at any time upon payment of the dues prescribed in Section III.

Affiliated Members are those members of a Local Section who are not otherwise connected with the Society. Their rights and privileges relate solely to the affairs of the Local Sections to which they belong.

All Honorary Members, Active Members, Associate Members and Corporation Members shall be equally entitled to the privileges of membership, except that only Active Members and one representative of each Corporation Member shall be entitled to vote. Such representative shall be officially designated by the person, firm or corporation represented. Only Active Members shall be entitled to hold office. The roster of each grade of membership shall be printed separately in at least one publication issued by the Society annually.

Any person may be expelled from any grade of the membership of the Society if charges signed by five or more Active Members be filed against him or her, and if the Board of Trustees examine into and sustain said charges

by a majority vote. Such person, however, shall be first notified of the charges against him and be given a reasonable time to appear before the Board of Trustees or to present a written defense, before final action is taken.

III Dues

Honorary Members shall be exempt from all fees or dues.

On and after February 1, 1920, no initiation fee shall be levied or collected from Associates upon promotion to Active Membership. The annual dues shall be fixed by the Board of Trustees and shall not exceed ten dollars, four dollars of which shall be a subscription to the *Journal of the American Ceramic Society*.

The initiation fee of Associate Members shall be five dollars, payable within three months after date of election. The annual dues shall be fixed by the Board of Trustees but shall not exceed five dollars, four dollars of which shall be a subscription to the *Journal of the American Ceramic Society*.

Affiliated Members are liable only for the dues and assessments of the Local Sections.

Corporation Members shall pay no initiation fee. The annual dues shall be fixed by the Board of Trustees, but shall not be less than twenty-five dollars, four dollars of which shall be a subscription to the *Journal of the American Ceramic Society*. The privileges of membership shall begin upon payment of the annual dues.

Any Active or Associate Member in arrears for over one year may be suspended from membership by the Board of Trustees until such arrears are paid and in event of continued dereliction, may be dropped from the rolls. Active Members in arrears are not eligible to vote. The annual dues of Active and Associate Members are payable within three months succeeding the date of the annual meeting.

IV Officers

The affairs of the Society shall be managed by a Board of Trustees consisting of the President, the Vice-President, (the Honorary Secretary, if there be one), the Treasurer, the retiring President, and his immediate predecessor, and three trustees. The President, the Vice-President. and the Treasurer shall be elected to serve one year. The Trustees shall be elected to serve three years, one Trustee being elected each year.

The Board of Trustees may from time to time, within their discretion, elect any past Secretary of the Society as Honorary Secretary to perform such duties as they may designate.

The President shall have general supervision of the affairs of the Society under the direction of the Board of Trustees and shall perform such other duties as pertain to his office.

He shall countersign the checks drawn by the Treasurer when such drafts are known by him to be proper and duly authorized by the Board of Trustees.

A Secretary shall be appointed annually by the Board of Trustees to serve for one year.

He shall see that all moneys due the Society are carefully collected and deposited in a Bank approved by the Board of Trustees, and he shall transfer monthly such funds to the custody of the Treasurer. The Secretary shall carefully scrutinize all expenditures and use his best endeavors to secure economy in the administration of the Society. He shall personally investigate and certify the accuracy of all bills or vouchers on which money is to be paid. He shall have charge of the books of account of the Society and shall furnish monthly to the Board of Trustees a statement of monthly balances. He shall present annually to the Board of Trustees a balance sheet of his books as of the 31st of December and shall furnish from time to time such other statements as may be required of him.

He shall conduct the correspondence of the Society and keep full records of the same. He shall transmit promptly to the Board of Trustees for their consideration all communications not of routine nature. He shall report promptly to all Active Members the results of all balloting on the business of the Society unless otherwise ordered by the Board of Trustees. He shall perform all other duties which may from time to time be assigned to him by the Board of Trustees.

The Secretary may be paid a salary to be determined by the Board of Trustees.

The Secretary shall furnish a suitable bond for the satisfactory performance of his duties, which shall be held in the custody of the President.

The Treasurer shall receive all moneys due the Society, and deposit the same in the name of the Society in a National Bank designated by the Treasurer and approved by the Board of Trustees. He shall invest all funds not needed for current disbursements, as shall be ordered by the Board of Trustees. He shall pay all bills by draft, when certified by the Secretary or as ordered by the Board of Trustees. He shall furnish a satisfactory bond for the proper performance of his duties, which shall be held in the custody of the President.

All securities belonging to the Society shall be held in the custody of the Treasurer.

The accounts of the Secretary and of the Treasurer shall be audited before each annual meeting by a certified public accountant or some other competent person designated by the Board of Trustees.

A vacancy in any office shall be filled by appointment by the Board of Trustees but the new incumbent shall not thereby be rendered ineligible for re-election to the same office at the next annual meeting. On the failure of any officer or any member of a committee to execute his duties within a reasonable time, the Board of Trustees, after duly warning such person, may declare the office vacant and appoint a new incumbent.

A majority of the Board of Trustees shall constitute a quorum, but the Board of Trustees shall be permitted to carry on such business as they may desire by letter.

V Elections

At the annual meeting a Nominating Committee of five Active Members, not officers of the Society, shall be appointed.

At least ninety days before the annual meeting this committee shall send the names of the nominees to the Secretary who will immediately send a copy of the same to each Active Member. Any five Active Members may act as a self-constituted Nominating Committee and present the names of any nominees to the Secretary, provided this is done at least thirty days before the annual meeting. The names of all nominees, provided their assent has been obtained before nomination, shall be placed on the ballot without distinction as to nomination by the regular or self-constituted Nominating Committee and shall be mailed to each Active Member, not in arrears, at least twenty days before the annual meeting. The voting shall be confined to the names appearing on this ballot. The ballot shall be enclosed in an envelope on which there shall be no mark for identification other than the word "Ballot." This envelope shall be enclosed in another envelope for mailing, addressed to the Secretary, upon the back of which the voter shall endorse his name. The ballot envelope shall be opened in the presence of three scrutineers appointed by the President, who will report the result of the election at the last session of the annual meeting. A plurality of affirmative votes cast shall elect.

VI Meetings

The annual meeting shall take place on the first Monday in February, or as soon thereafter as can be arranged, at such place as the Board of Trustees may decide, at which time reports shall be made by the Board of Trustees, Treasurer, and scrutineers of election, and the accounts of the Treasurer shall be audited by a committee of three appointed by the President. Ten active members shall constitute a quorum at any regular meeting and a majority shall rule unless otherwise specified.

The order of business at the annual meeting shall be

1. President's address.
2. Reading of minutes of last meeting.
3. Reports of the Board of Trustees and Treasurer.
4. Old business.
5. New business.
6. Reading of papers.
7. Announcement of election of officers, Honorary and Active Members.
8. Installation of officers and new members.
9. Appointment of committees.
10. Adjournment.

Other meetings may be held at such times and places during the year as the Board of Trustees may decide, but at least twenty days' notice shall be given of any meeting.

The President shall appoint at the annual meeting a committee of five, to be known as the Summer Meeting Committee, whose duty it shall be to arrange for a summer excursion meeting at some suitable point. The expenses of the Summer Meeting Committee in arranging the program of visits and for printing, rooms, and facilities for meetings shall be borne by the Society.

VII Standing Committees

The following Standing Committees shall be appointed annually by the Board of Trustees:

1. Rules.
2. Publications.
3. Membership.
4. Standards.
5. Sections and Divisions.
6. Papers and Programs.
7. Coöperation.
8. Research and Development.

The Committee on Rules shall consist of five members. It shall receive all recommendations relating to changes of Rules and shall report upon the same to the Secretary for transmission to the Society. It shall have power to propose changes in the Rules of the Society.

The Committee on Publications shall consist of the Editor and four members. The duties of the Editor and Committee on Publications are defined under Article XI on Publications.

The Committee on Membership shall consist of at least five members and shall have the power to appoint sub-committees. Its function shall be to undertake systematically the enlargement of the membership of the Society amongst those interested in the silicate and allied industries.

The Committee on Standards shall consist of at least five members and shall have the power to appoint sub-committees. It shall submit written reports, resolutions, and recommendations, relating to tests of materials and products. The Committee may report at any regular meeting of the Society. For adoption, these reports, resolutions, and recommendations must be submitted in printed form to the members of the Society at least six months before a vote may be taken, during which time any amendments, changes, or corrections suggested by any member may with the approval of the Committee be incorporated in the report, resolution, or recommendation. The reports, resolutions, and recommendations as amended shall then be submitted by le ter ballot to the Active Members. A two-thirds vote shall be required for adoption.

The Committee on Sections and Divisions shall consist of five members. Its duties shall be to promote the organization and welfare of Local Sections, Student Branches, and Divisions.

The Committee on Papers and Programs shall consist of the Chairmen of

the various Divisions, the Secretary of the Society, and such other persons as the Board of Trustees may deem advisable. Its duties shall be to procure papers and discussions for the meetings and publications of the Society. The Committee may require an abstract of any paper submitted before placing it upon a program.

The Committee on Coöperation shall consist of at least five members. Its duties shall be to promote the interests of the Society by coöperation with other societies and organizations and to secure recognition of the Society by any proper means.

The Committee on Research and Development shall consist of five members. Its duties shall be to organize and encourage scientific investigations pertaining to the silicate and related industries especially those investigations which will stimulate the development of our national industries and resources. It shall be empowered to coöperate with similar committees of other scientific societies and with Government bureaus.

VIII Divisions

Professional groups to be known as Divisions of the Society and to be organized from members of the Society may be authorized by the Board of Trustees for stimulating the growth and development of the Society, when such action shall seem wise and expedient. Any member of the Society may register in any Divisions of the Society in which he is interested.

The affairs of a Division shall be managed by a Chairman, a Secretary-Treasurer, and a Council of four members. The officers of the Division and two members of the Council shall be elected annually by ballot at the last session of the Division held during the annual meeting of the Society and shall take office at the close of the meeting at which they are elected. All members of a Division are entitled to vote. The members of the Council shall hold office for two years. The officers shall hold office for one year or until their successors are elected. The Board of Trustees shall fill any vacancies occurring through death or resignation among officers of a Division.

A Division shall have the right to make by-laws for its own government, which shall be subject to the approval of the Board of Trustees and must not be inconsistent with the Rules of the Society, and a committee to draw up such by-laws shall be appointed at the first meeting held by the Division.

Any Division may raise or collect funds to be expended for its own purposes and may have the entire management and control of said funds, insofar as said management and control does not conflict with any provisions of the Rules or with the Charter of the Society.

The Secretary-Treasurer of each Division shall make an annual report to the Society of the activities and finances of the Division.

Any Division may be dissolved by the Board of Trustees for good and sufficient reasons.

IX Local Sections

Local Sections, each carrying some distinguishing title prefixed to the

words "Section of the American Ceramic Society," may be authorized by the Society.

The purposes of such sections shall be to strengthen and extend the work of the Society as defined in Section I of its Rules by more frequent meetings in local centers than are possible to the Society as a whole and by bringing the benefits of the work to persons who would not otherwise be reached.

Application for permission to form a Local Section must be in writing and signed by not less than ten members of the Society in good standing, residing in the general locality where the Section is to be formed, of whom one at least shall be an Active Member. To be considered at any given meeting an application must be filed with the Secretary at least thirty days prior to the date of the meeting and notice that the application is pending must appear in the program of the meeting. To be granted, the application must receive the affirmative vote of two-thirds of those present. In event of affirmative action the Society will issue a charter to the applicants authorizing them to form a Section under the name proposed. Charters for Local Sections may be temporarily suspended by the Board of Trustees for cause, but no charter can be permanently rescinded except by vote of two-thirds of those present at a regular meeting of the Society, after due publication in the program of the meeting that the matter is pending.

Local Sections shall have power to make their own rules and by-laws except that they shall not pass any rule or by-law which is in conflict with the Rules of the Society.

The officers of Local Sections shall be a Chairman, a Secretary, a Councilor, and such others as the Section may prescribe. The duties of the Chairman and Secretary shall be such as usually pertain to those offices. The Councilor shall be an Active Member of the Society. He shall be elected by the Local Section and it shall be his duty to advise the Section in all matters pertaining to its relations with the Society and to make an annual report to the Society regarding the work and status of the Section. The names of the Chairman, Secretary, and Councilor of each Section shall appear in the roster of the Society.

Any person interested in the silicate and allied industries is eligible to membership in a Local Section.

Local Sections shall have power to fix their own dues or assessments, such dues or assessments being in addition to and independent of the regular dues and assessments of the Society upon its members. No Section shall have authority to incur debt in the name of the Society or for which the Society may become liable.

X Student Branches

Student Branches, each carrying some distinguishing title prefixed to the words "Student Branch of the American Ceramic Society," may be established in institutions in which regular courses of instruction in ceramics are maintained.

The purpose of such Student Branches shall be to strengthen and extend the work of the Society, as defined in Section I of the Rules, by enlisting the interest and support of students in ceramics while still in school and by stimulating the spirit of ceramic research among them.

Application to form a Student Branch in any institution must be in writing, signed by not less than five regularly enrolled students in good standing and endorsed by two or more members of the Society. The application must be filed and acted upon as provided for Local Sections in Section IX, and may be suspended or revoked for cause in the same manner.

Student Branches shall have power to make their own rules and by-laws, except that they shall not pass any rule or by-law in conflict with the Rules of the Society.

The officers of Student Branches shall be a Chairman, a Secretary, a Councilor, and such others as the Student Branch may prescribe. The Chairman and Secretary shall be elected by the Student Branch and their duties shall be such as usually pertain to those offices. The Councilor shall be an Active Member of the Society, appointed by the Board of Trustees to act in this capacity to the Student Branch. The duties of the Councilor shall be to advise the Student Branch in all matters pertaining to its relations to the Society and to make an annual report to the Society regarding the work and status of the Student Branch. The names of the Chairman, Secretary, and Councilor for each Student Branch shall appear in the roster of the Society.

Membership in a Student Branch shall be limited to the instructional force and regularly enrolled students of schools in which branches are located, subject to the rules of the school concerned governing outside activities of students.

Student Branches shall have power to fix their own dues and assessments and, as such, shall pay no dues or initiation fees to the Society. No Student Branch shall have authority to incur debt in the name of the Society or for which the Society may become liable.

Members of a Student Branch as such shall pay no dues or initiation fees to the Society but upon depositing a certificate of good standing from their Secretary, may purchase from the Society its publications at the same rate as Associate Members of the Society. This privilege shall cease when the student's connection with the school ceases, but members of a Student Branch, upon leaving school, may at once become Associate Members of the Society by depositing their certificates, making proper application, and paying the regular initiation fee.

XI Publications

The Board of Trustees may employ, at a suitable compensation, an editor of the publications of the Society.

The Committee on Publications shall have general supervision of the publications of the Society and of contracts and expenditures connected therewith, subject to the approval of the Board of Trustees.

In the consideration of papers offered for presentation or publication those papers containing matter readily found elsewhere, those specially advocating personal interests, those carelessly prepared or controverting established facts, and those purely speculative or foreign to the purposes of the Society, shall be rejected. The Committee on Publications shall determine which papers shall be printed. The Committee may return a paper to the writer for correction and emendation and may call to its aid one or more members of special experience relating to the subject treated, either to advise on the paper or to discuss it.

The Committee on Publications shall provide for the publication of a monthly periodical entitled the *Journal of the American Ceramic Society*, the subscription price of which shall be four dollars to members and six dollars to non-members.

One copy of each issue of the paper-bound edition of the Journal shall be sent prepaid to each member of the Society not in arrears. No member shall be furnished with more than one copy of each issue free for any single year. A member may be permitted to complete by purchase one file of the publications of the Society at less than the current commercial rate, the amount to be fixed by the Board of Trustees and to be called the member's rate.

The Secretary shall have the custody of all publications of the Society, shall keep them safely stored and insured, and shall sell them to the public at prices which shall be fixed by the Board of Trustees. The Board of Trustees shall also, from time to time, fix the price of the volumes remaining unsold and shall have authority to refuse to sell the back volumes of the Transactions and Journals except in complete sets, at such time as the quantity remaining of any number becomes so small as in their judgment to warrant such action.

The Editor shall request the author of each article appearing in the Journal of the Society to fill out and sign, within a definite time limit, a form, specifying the number of reprints of said article, if any, which he desires. This form shall contain a table from which can be computed the approximate cost at which any reprints will be furnished. In event that the expense of furnishing the desired number of reprints is large, the Board of Trustees may require the author to pay part or all of the cost involved before the publication of the reprints is begun. On receipt of such signed order within the time limit set the Editor shall cause to have prin'ed the desired number of copies. If the author makes no reply or replies after the time limit has expired then the Society will not be responsible for the publication of any reprints of the article in question except at the usual market price for the printing of new matter.

No one shall have the right to demand the publication of an article independent of the discussion which accompanied it and no one having taken part in a discussion upon an article shall be entitled to order reprints of the discussion separately and apart from the article itself.

The Society is not, as a body, responsible for the statement of facts or opinions expressed by individuals in its publications.

XII Parliamentary Standard

Roberts' "Rules of Order" shall be the parliamentary standard on all points not covered by these rules.

XIII Amendments

To amend these Rules the amendment must be presented in writing at a regular meeting of the Society and, if approved by the Committee on Rules or by any ten Active Members, must be printed on a ballot and sent out not earlier than thirty nor later than sixty days after the adjournment of the meeting at which the amendment was presented. If the said letter ballot shows an affirmative vote of not less than two-thirds of the total vote cast within fourteen days of the date of mailing, then the same shall be declared carried and shall at once become effective.

"In Memoriam" 1919-1920

Bramlett, J. T.

Gregori, L. P.

Nelson, Idris

Sweet, George

Wagner, Fritz

Young, George F.

MEMBERSHIP LISTS, May 1, 1920

Honorary Members

Branner, John C., *Ph.D.*, President, Leland Stanford Junior University, Stanford University, Cal.

English Ceramic Society, Mr. R. J. Johnson, President, Oulton Rocks, Stone, Staffordshire, England.

Storer, Mrs. Maria Longworth (Mrs. Bellamy Storer), Founder of the Rookwood Pottery, Cincinnati, Ohio.

Resident Active Members

Arnold, H. C., 284 South Main St., Washington, Pa.

Ashbaugh, Chas. C., East Liverpool, Ohio, Secretary and Treasurer, West End Pottery Company.

Aubrey, Arthur J., Youngstown, Ohio, Assistant General Superintendent, Bessemer Limestone Company.

Babcock, M. G., 241 McKee Place, Pittsburgh, Pa., McCullough-Dalzell Crucible Company.

Bacon, Raymond F., Pittsburgh, Pa., Director, Mellon Institute.

Barringer, L. E., Schenectady, N. Y., Engineer of Insulations, General Electric Company.

Barton, G. E., 227 Pine St., Millville, N. J., Chief Chemist and Technical Expert, Whitall Tatum Company.

Bates, P. H., 3220 Morrison St., Chevy Chase, D. C., U. S. Bureau of Standards.

Beecher, M. F., Worcester, Mass., Research Laboratories, Norton Company.

Bell, M. L., 901 South Ave., Wilkinsburg, Pa., Ceramic Engineer, Carnegie Steel Company, Braddock, Pa.

Bently, Louis L., Beaver Falls, Pa., Superintendent, Armstrong Cork Company.

Berry, C. W., St. Louis, Mo., Chemist, Laclede-Christy Clay Products Company.

Binns, Chas. F., Alfred, N. Y., Director, New York State School of Clay-Working and Ceramics.

Blair, Marion W., 411 Front St., Ridgway, Pa., Superintendent, Yingling Martin Brick Company, Johnsonburg, Pa.

Blair, William P., 824 B. of L. E. Bldg., Cleveland, Ohio, Secretary, National Paving Brick Manufacturers Association.

Bleininger, A. V., Washington, D. C., U. S. Bureau of Standards.

Bloomfield, Chas. A., Metuchen, N. J., Treasurer, Bloomfield Clay Company.

Boeck, Percy A., 11 Broadway, New York City, Celite Products Company.

Bole, George A., Alfred, N. Y., Professor of Chemistry, New York State School of Clay-Working and Ceramics.

Booze, M. C., 264 Burncoat St., Worcester, Mass., Norton Company.
Bowman, Wm. J. J., Trenton, N. J., Trenton Fire Clay and Porcelain Company.
Brockbank, Clarence J. (address unknown).
Brown, George H., New Brunswick, N. J., Director, Department of Ceramics, Rutgers College.
Bryan, M. L., Spokane, Wash., Washington Brick Lime and S P Company.
Burt, S. G., 2349 Ashland Ave., Cincinnati, Ohio, Rookwood Pottery.
Campbell, A. R., Middlesex Ave., Metuchen, N. J., Federal Terra Cotta Company.
Cannan, Wm., Jr., 522 Allen St., Syracuse, N. Y., Onondaga Pottery.
Carder, Frederic R., Corning, N. Y., Steuben Glass Works.
Cermak, Frank, 116 Fourth Ave., Schenectady, N. Y., Foreman, Porcelain Works, General Electric Company.
Child, J. L., Findlay, Ohio, Hancock Brick and Tile Company.
Clare, R. L., Woodbridge, N. J., Superintendent, Federal Terra Cotta Company.
Clark, Wm. M., Cleveland, Ohio, Glass Technology Department, National Lamp Works of General Electric Company.
Conkling, Samuel O., Philadelphia, Pa., Superintendent, Conkling-Armstrong Terra Cotta Company.
Cook, Chas. H., Trenton, N. J., Cook Pottery Company.
Cowan, R. G., 1360 Nicholson Ave., Cleveland, Ohio, Cowan Pottery.
Cox, Paul E., 1308 Dauphine St., New Orleans, La.
Creighton, E. E. F., 27 Wendell Ave., Schenectady, N. Y., Consulting Electrical Engineer, General Electric Company.
Danielson, R. R., Washington, D. C., U. S. Bureau of Standards.
Davis, John B., *D.D.S.*, 22 East Greenwood Ave., Lansdowne, Pa.
Day, A. L., *Ph.D.*, Washington, D. C., Director, Geophysical Laboratory.
Dornbach, Wm. E., 3514 Clifton Ave., Baltimore, Md., American Refractories Company.
Duval d'Adrian, A. L., 284 South Main St., Washington, Pa.
Ellerbeck, Wm. L., *D.D.S.*, Box 917, Salt Lake City, Utah, President and Manager, Nephi Plaster Company.
Emley, Warren E., Washington, D. C., U. S. Bureau of Standards.
Fackt, George P., Denver, Colo., General Manager, Denver Terra Cotta Company.
Farnham, Dwight T., 99 Oak St., Binghamton, N. Y., Industrial Engineer.
Fickes, Walter M., Niagara Falls, N. Y., Aluminum Company of America, No. 3 Works.
Fiske, J. Parker B., Arena Bldg., New York City.
Frink, R. L., Lancaster, Ohio, President, Frink Laboratories.
Frost, Leon J., Geneva, N. Y., Phillips & Clark Stove Company.
Fulper, William H., Flemington, N. J., Secretary-Treasurer, Fulper Pottery.
Fulton, C. E., Creighton, Pa., Pittsburgh Plate Glass Company.

Galpin, S. L., Ames, Iowa, Professor, Department of Mining and Geology, Iowa State College.

Garve, T. W., 2782 North High St., Columbus, Ohio, Secretary-Treasurer, The Ceramic Supply and Construction Company.

Gates, Ellis D., 1808 Prairie Ave., Chicago, Ill., American Terra Cotta and Ceramic Company.

Gates, William D., 1808 Prairie Ave., Chicago, Ill., President and General Manager, American Terra Cotta and Ceramic Company.

Geijsbeek, Samuel, Burke Bldg., Seattle, Wash., Consulting Chemical Engineer, Geijsbeek Engineering Company.

Gelstharp, Frederick, Creighton, Pa., Chemist, Pittsburgh Plate Glass Company.

Gillinder, James, 11 Orange St., Port Jervis, N. Y., Superintendent, Gillinder Brothers.

Gorton, Arthur F., *Ph.D.*, Toledo, Ohio, Research Physicist, Buckeye Clay Pot Company.

Grady, Robert F., St. Louis, Mo., Manager, St. Louis Terra Cotta Company.

Greaves-Walker, A. F., Yale Hotel, Chewelah, Wash., American Refractories Company.

Gregory, M. E., Corning, N. Y., Proprietor, Corning Brick, Terra Cotta and Tile Company.

Grueby, William H., Boston, Mass., Grueby Faience Company.

Haaf, George, 2701 Milton Ave., Solvay, N. Y., General Foreman, Pass and Seymour, Inc.

Hall, Robert T., East Liverpool, Ohio, Secretary and Treasurer, Hall China Company.

Hansen, Abel, Fords, N. J., Proprietor, Fords Porcelain Works.

Harrop, Carl B., Lord Hall, Ohio State University, Columbus, Ohio, Assistant Professor of Ceramic Engineering.

Hart, Edward, *Ph.D.*, Easton, Pa., Professor of Chemistry, Lafayette College.

Henderson, H. B., 1538 North High St., Columbus Ohio, Superintendent, Orton Pyrometric Cone Factory.

Henry, Frank R., *M.D.*, Dayton, Ohio, Manager, Dayton Grinding Wheel Company.

Hice, Richard R., *Sc.D.*, Beaver, Pa., State Geologist, Topographic and Geologic Survey Commission of Pennsylvania.

Hill, E. C., Philadelphia, Pa., Conkling-Armstrong Terra Cotta Company.

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Cunningham, M. F., Waltham, Mass., Superior Corundum Wheel Company.

Cutting, J. W., Elkton, Md.

Czerny, Leonard (address unknown).

Dailey, Ernest W., Mason City, Iowa, Secretary and Manager, North Iowa Brick and Tile Company.

Dains, I. F., Monmouth, Ill., President and General Manager, Western Stoneware Company.

Darlington, Homer T., Box 736, Natrona, Pa., Metallurgical Engineer, Pennsylvania Salt Manufacturing Company.

***Davenport, R. W.,** Detroit, Mich., Jeffery-Dewitt Company.

Davies, J. L., Clayton, Wash., Superintendent, Washington Brick, Lime, and S P Company.

Davis, Harold E., 115 Bacon St., Waltham, Mass., Superintendent, Waltham Grinding Wheel Company.

Davis, Harry E., Chicago, Ill., Northwestern Terra Cotta Company.

***Dean, Charles A.,** 79 Twelfth Ave., Columbus, Ohio.

Deaver, L. A., 29 Dodge Ave., Akron, Ohio.

Dell, John M., St. Louis, Mo., Missouri Fire Brick Company.

Denk, F. J., 1216 House Bldg., Pittsburgh, Pa., Consulting Engineer.

Dennis, J. Alfred, Trenton, N. J., Superintendent, Golding Sons Company.

***DeVoe, Charles H.,** Old Bridge, N. J., Superintendent, Old Bridge Enameled Brick and Tile Company.

DeVol, E. M., Zanesville, Ohio, Superintendent, Zanesville Stoneware Company.

DeWitt, Bert G., New Philadelphia, Ohio, Superintendent, Belmont Stamping and Enameling Company.

***Dickey, Fred L.,** Kansas City, Mo., General Manager, W. S. Dickey Clay Manufacturing Company.

* Elevated to Active Membership, February, 1920.

Dimcombe, George H., Jr., 1915A McCausland Ave., St. Louis, Mo., Evens & Howard Fire Brick Company.

***Dinsmore, B. B.,** Trenton, N. J., General Manager, Imperial Porcelain Works.

Dittmar, Carl, 518 Union Central Bldg., Cincinnati, Ohio, Resident Manager, Roessler & Hasslacher Chemical Company.

Dixon, Henry L., Pittsburgh, Pa., President and General Manager, H. L. Dixon Company.

***Dobbins, T. M.,** Camden, N. J., Secretary and Treasurer, Camden Pottery Company.

Dolley, Charles S. (address unknown).

Dolman, C. D., Chewelah, Wash., Chief Chemist, Northwest Magnesite Company.

Douda, Henry W., 1927 Waldeck Ave., Columbus, Ohio, U. S. Bureau of Mines.

Drakenfeld, B. F., Jr., 50 Murray St., New York City, Treasurer, B. F. Drakenfeld & Company, Inc.

Dressler, Conrad, 171 Madison Ave., New York City, American Dressler Tunnel Kilns, Inc.

Dressler, Philip, 375 Converse Ave., Zanesville, Ohio, American Dressler Tunnel Kilns, Inc.

***Dunn, Frank B.,** Conneaut, Ohio, President and Treasurer, Dunn Wire Cut Lug Brick Company.

Durant, E. M., 603 American Bank Bldg., Los Angeles, Cal., President, Pacific Sewer Pipe Company.

***Ebinger, D. H.,** 735 Linwood Ave., Columbus, Ohio, Secretary and General Manager, D. A. Ebinger Sanitary Manufacturing Company.

Eckert, E. W., Box 65, Derry, Pa., Electrical Engineer, Pittsburgh High Voltage Insulator Company.

***Edgar, David R.,** Metuchen, N. J., Assistant General Manager, Edgar Brothers Company.

Edwards, W. L., Tiltonsville, Ohio, Assistant Superintendent, Wheeling Sanitary Manufacturing Company.

Eilers, H. F., 162 Watauga Ave., Corning, N. Y., Corning Glass Works.

Ellinwood, R. S., Geneva, N. Y., General Manager, Geneva Glass Products, Inc.

Emminger, Thos. F., Pittsburgh, Pa., General Superintendent, Pittsburgh Clay Pot Company.

Emrick, W. A., Derry, Pa., Assistant to General Superintendent, Pittsburgh High Voltage Insulator Company.

Enright, Bernard, 1431 Collings Ave., Yorkship Village, Camden, N. J.

***Eskesen, Bennet K.,** Matawan, N. J., Superintendent, New Jersey Mosaic Tile Company.

Eskesen, E. V., 149 Broadway, New York City, General Manager, New Jersey Terra Cotta Company.

* Elevated to Active Membership, February, 1920.

Evans, A. W., Zanesville, Ohio.

Evatt, Franks G., 1170 Broadway, New York City, Vice-President, Atlantic Terra Cotta Company.

Farren, Mabel C., 3600 Forbes St., Pittsburgh, Pa., Private Studio.

Faulkner, Karl B., Corning, N. Y., Foreman, Pot Department, Corning Glass Works.

Fenton, Harry W., Mogadore, Ohio, Assistant General Manager, Akron Smoking Pipe Company.

Ferguson, Richard D., 2036 South 26th St., Lincoln, Neb.

Ferguson, Robert F. (address unknown).

Fettke, Charles R., Pittsburgh, Pa., Carnegie Institute of Technology.

Finney, Robert S., 142 W. 80th St., New York City.

***Fisher, Douglas J.,** Sayreville, N. J., Sayre & Fisher Company.

Fisher, E. E., Toledo, Ohio, Modern Glass Company.

***Fisher, George P.,** Ottawa, Ill., Superintendent, National Fireproofing Company.

Fitzpatrick, John, 533 10th St., Niagara Falls, N. Y., Carborundum Company.

Flagg, Frederick P., 20 Floyd St., Waltham, Mass., Chief Chemist, Waltham Watch Company.

Flint, Francis C., 331 South Main St., Washington, Pa., Chief Chemist, Hazel-Atlas Glass Company.

Foersterling, Hans, *Ph.D.*, The Abor Farm, Jamesburg, N. J.

Foltz, Andrew, 187 North Union St., Lambertville, N. J., President, Lambertville Pottery Company.

Footitt, F. Farnsworth, Hoboken, N. J., American Lead Pencil Company.

Ford, G. Bergen, Caudler Bldg., Atlanta, Ga., B. Mifflin Hood Company.

Forester, Herbert, Box 37, Cleveland, Ohio, Principal, Veritas Firing System Company.

Forman, L. P., Arnold, Pa., American Window Glass Company.

***Forst, Arthur D.,** Trenton, N. J., President, Robertson Art Tile Company.

Forst, D. Parry, 216 West State St., Trenton, N. J., Robertson Art Tile Company.

Foskett, John J., Port Jervis, N. Y., President and Manager, Foskett and Company, Inc.

Foster, Harry D., 219 West 10th Ave., Columbus, Ohio, Student, Ohio State University.

Fowler, William E., Paxtonville, Pa., Paxton Brick Company.

Frantz, Samuel G., Crossett, Ark., Crossett Lumber Company.

Franzheim, C. Merts, Wheeling, W. Va., The Charles M. Franzheim Company.

***Fraser, W. B.,** Dallas, Texas, President, Fraser Brick Company.

***Fraunfelter, Charles D.,** Zanesville, Ohio, President, Ohio Pottery Company.

***Freese, H. H.,** 446 South Union St., Galion, Ohio, Mechanical Engineer, E. M. Freese Company.

* Elevated to Active Membership, February, 1920.

Fridricksen, Christian, Pleasant Valley, Wheeling, W. Va.

Fritz, E. H., Box 510, Derry, Pa., Ceramic Engineer, Westinghouse Electric and Manufacturing Company.

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Fuller, Ralph L., 720 Electric Bldg., Cleveland, Ohio, Harshaw, Fuller & Goodwin Company.

Fulton, Kenneth I., 316 East Main St., Portland, Ind.

***Fulweiler, Walter H.,** 319 Arch St., Philadelphia, Pa., Chief Chemist, United Gas Improvement Company.

***Gahris, Willard I.,** Sebring, Ohio, Limoges China Company.

Galloway, Walter B., Philadelphia, Pa., President, Galloway Terra Cotta Company.

Garrison, Amos, 2543 S. 5th St. E., Salt Lake City, Utah.

Garrod, Fred B., Toledo, Ohio, Chemist, Owens Bottle Company.

***Gates, A. W.,** Colchester, Ill., President and Treasurer, Gates Fire Clay Company.

***Gates, Major E.,** Terra Cotta, Ill., Superintendent, American Terra Cotta and Ceramic Company.

Gavin, Gordon P., Kalamazoo, Mich., Superintendent, Kalamazoo Sanitary Manufacturing Company.

Gaylord, George L., 14 Holland Ave., Westfield, Mass., General Manager, Vitrified Wheel Company.

Gehrig, Edward F., Detroit, Mich., Research Engineer, Detroit Stove Works.

Geiger, Carl F., 7 Baltimore St., Dayton, Ohio, Chief Draughtsman and Engineer, Manufacturers Equipment Company.

***Geiger, Charles F.,** 1627 Linwood Ave., Niagara Falls, N. Y., Carborundum Company.

Geisinger, E. E., Rochester, N. Y., The Pfaudler Company.

Geller, Roman F. ,Washington, D. C., U. S. Bureau of Standards.

George, J. S., 135 Rebecca St., Kittanning, Pa., U. S. Bureau of Standards, Pittsburgh, Pa.

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Gerber, Albert C., 1768 North Taylor Rd., East Cleveland, Ohio.

***Gibbs, Arthur E.,** 1006 Widener Bldg., Philadelphia, Pa., Head of Research Department, Pennsylvania Salt Manufacturing Company.

Giesey, V. A., 318 Citizens Bldg., Cleveland, Ohio, President, National Refractories Company.

Gilbert, Frank W., Rochester, Pa., Pittsburgh Grinding Wheel Company.

Gilmore, R. B., E. Liberty Branch, Y. M. C. A., Pittsburgh, Pa., Ceramic Engineer, Vesuvius Crucible Company.

***Gladding, Augustus L.,** Lincoln, Cal., Gladding, McBean & Company.

* Elevated to Active Membership, February, 1920.

Gleason, Marshall W., 864 Park Place, Brooklyn, N. Y., President and General Manager, Gleason-Tiebout Glass Company.

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Goheen, John P., Philadelphia, Pa., Secretary, The Brown Instrument Company.

Golding, Charles E., 217 South Warren St., Trenton, N. J., Manager, Trenton Department, Golding Sons Company.

Goldsmith, B. B., 19 East 74th St., New York City, Vice-President, American Lead Pencil Company.

Good, Harry N., Pittsburgh, Pa., Ceramic Engineer, Pittsburgh Testing Laboratory.

Goodman, A. H., Box 915, Pittsburgh, Pa., Sales Engineer, Blaw-Knox Company.

Goodwin, Herbert, Salem, Ohio, General Superintendent, Salem China Company.

Grace, Richard P., Woodbridge, N. J., Superintendent, Mutton Hollow Fire Brick Company.

Grafton, Charles O., Muncie, Ind., Treasurer and General Manager, Gill Clay Pot Company.

Graham, E. H., Los Angeles, Cal., Secretary and Manager, Washington Iron Works.

Grainer, John S., Box 21, Spring Lake, Mich., Challenge Refrigerator Company, Grand Haven.

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*__Grant, DeForest,__ 101 Park Ave., New York City, President, Federal Terra Cotta Company.

Grant, W. Henry, St. Marys, Pa., Elk Fire Brick Company.

Gray, Arthur E., Pittsburgh, Pa., Treasurer and General Manager, Pittsburgh Clay Pot Company.

*__Green, J. L.,__ St. Louis, Mo., President, Laclede-Christy Clay Products Company.

Greene, R. W., Mayfield, Ky., Kentucky Construction and Improvement Company.

Greener, George C., 198 Clarendon St., Boston, Mass., Director, North Bennett Street Industrial School.

Greenwood, G. W., Uniontown, Pa., United Fire Brick Company.

Greenwood, John L., Lehigh, Iowa, Superintendent, Lehigh Sewer Pipe and Tile Company.

Gregori, John N., Chicago, Ill., Kiln Burner, Northwestern Terra Cotta Company.

* Elevated to Active Membership, February, 1920.

Gregorius, Thomas K., Corning, N. Y., Ceramic Engineer, Corning Glass Works.

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Gunniss, Wm. H. (address unknown).

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Guthrie, Lee, Elyria, Ohio, Foreman, Elyria Enameled Products Company.

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Haeger, E. H., Dundee, Ill., President, The Haeger Potteries, Inc.

Hagar, Donald, Detroit, Mich., Jeffery-Dewitt Company.

***Haley, Mark A.,** Syracuse, N. Y., Onondaga Pottery Company.

***Hall, Clarence A.,** Cresheim Arms, Allen Lane, Mt. Airy, Philadelphia, Pa.

Hall, Herman A., Vanport, Pa., McLain Fire Brick Company.

Hall, William C., 1302 3rd National Bank Building, Atlanta, Ga., Vice-President, Atlanta Terra Cotta Company.

Hamilton, James, Trenton, N. J., Superintendent, Ideal Pottery of The Trenton Potteries.

Handke, Paul A., 260 S. Academy St., Galesburg, Ill., Purington Paving Brick Company.

Hanna, Harold H., Crystal City, Mo., Pittsburgh Plate Glass Company.

Hardesty, B. D., Syracuse, N. Y., Iroquois China Company.

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***Hardy, Isaac E.,** Momence, Ill., Superintendent, Tiffany Enameled Brick Company.

Hare, Robert L., Upper Sandusky, Ohio, Manager, Wyandot Clay Products Company.

***Harker, H. N.,** East Liverpool, Ohio, President, Harker Pottery Company.

Harker, O. A., Jr., Puryear, Tenn., President and Manager, Dixie Brick and Tile Company.

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Harrell, E. R., Checotah, Okla., Superintendent, Graham Glass Company.

Harris, Marshall W., 227 East Park Place, Oklahoma City, Okla., Student, University of Illinois.

Harvey, F. A., Syracuse, N. Y., Laboratory Physicist, Solvay Process Company.

Harvey, Ives L., Bellefonte, Pa.

* Elevated to Active Membership, February, 1920.

Harvey, J. Ellis, Orviston, Pa., General Manager, Centre Brick and Clay Company.

***Hasburg, John W.,** 1119 La Salle Ave., Chicago, Ill., President, John W. Hasburg Company, Inc.

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Hasslacher, Jacob, 709–717 Sixth Ave., New York City, President, Roessler & Hasslacher Chemical Company.

***Hastings, Francis N.,** Hartford, Conn., Hartford Faience Company.

***Hatton, Richard D.,** 1673 Railway Exchange Bldg., St. Louis, Mo., Vice-President and General Manager, Laclede-Christy Clay Products Company.

Healey, A. S., Elizabeth, N. J., Superintendent, Standard Sanitary Pottery Company.

Heath, Fred T., 4505 Eighteenth Ave., N. E., Seattle, Wash., Student, University of Washington.

Heistand, Elza F., Muncie, Ind., Superintendent, Crucible Department, Gill, Clay Pot Company.

Helser, P. D., Flint, Mich., Ceramic Engineer, Champion Ignition Company.

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Hepplewhite, J. W., 1835 Indianola Ave., Columbus, Ohio, U. S. Bureau of Mines.

Herbst, Abram W., Canaan, Conn., New England Slag Company.

Herrell, Carson, Kokomo, Ind., Secretary and Treasurer, Kokomo Sanitary Pottery Company.

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Heuisler, Philip I., Baltimore, Md., President, Maryland Glass Corporation.

Hewitt, L. C., 4928-A Itaska St., St. Louis, Mo., Chief Dispatcher, Laclede-Christy Clay Products Company.

Hibbins, Thomas A., Wellsville, Ohio, General Business and Sales Manager, The Stevenson Company.

Hibbs, Jos. S., 3203 West Columbia Ave., Philadelphia, Pa., Assistant General Manager, J. W. Paxson Company.

Hill, Charles W., Perth Amboy, N. J., General Works Manager, Atlantic Terra Cotta Company.

* Elevated to Active Membership, February, 1920.

Hill, Jas. H., 604–608 Pacific Electric Bldg., Los Angeles, Cal., President, Alberhill Clay and Coal Company.

Hinrichs, Carl G., 4112 Shenandoah Ave., St. Louis, Mo., Consulting and Analytical Chemist, Hinrichs Laboratories.

Hintze, T. Forsyth, 120 Liberty St., New York City, Gas Engineer.

Hitchins, R. E., Olive Hill, Ky., General Manager, General Refractories Company.

Hoehn, F. J., 703 South West St., Carlinville, Ill.

Hollingsworth, C. M., Steubenville, Ohio, Ohio Valley Clay Company.

Hollmeyer, John G., 5210 Norwood Park Ave., Chicago, Ill., Secretary Treasurer, American China Company.

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Holmes, J. C., Sandusky, Ohio, Superintendent, Sandusky Bulb Works.

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Hostetter, J. C., *Ph.D.*, Corning, N. Y., Physical Chemist, Corning Glass Works.

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Houser, A. T., Pittsburgh, Pa., Manager, Woods Lloyd Company.

Hower, H. S., Pittsburgh, Pa., Professor of Physics, Carnegie Institute of Technology.

Hudson, Charles J., 39 Kingsbury St., Worcester, Mass., Special Investigator, Norton Company.

Hung, Shen, 366 Harvard St., Cambridge, Mass.

Hunt, Frank S., Beaver Falls, Pa., Beaver Falls Art Tile Company.

Hunt, Marsden H., Kenova, W. Va., Jeffery-Dewitt Insulator Company.

Huston, C. H., Chattanooga, Tenn., Chattanooga Stamping and Enameling Works.

Irwin, Dewitt, East Liverpool, Ohio, Secretary, Potters Supply Company.

***Ittner, Warren W.,** 5500 Pershing Ave., St. Louis, Mo., Treasurer, General Clay Products Company.

Jackson, H. W., DuBois, Pa., General Manager, Jackson China Company.

Jacquart, Chas. E., South River, N. J., American Enameled Brick Company.

Jaeger, Frank G., St. Louis, Mo., Superintendent, Bucks Stove and Range Company.

James, W. Roy, 118 W. 14th St., Marion, Ind., Bethevan Factory, Macbeth Evans Glass Company.

Jenks, H. P., Columbus, Ohio, Manager, Hook Patent Kiln Company.

Jensen, James L., 156 Greene St., Brooklyn, N. Y., Assistant Manager, Empire China Works.

Jewett, Fred E., Muncie, Ind., General Superintendent, Ball Brothers Glass Manufacturing Company.

* Elevated to Active Membership, February, 1920.

Jewett, Richmond, Lackawanna, N. Y., Superintendent, Jewett Refrigerator Company.

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*__Johnston, John,__ *Ph.D.*, Box 703, Yale Station, New Haven, Conn.

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Jones, Otis L., Ogelsby, Ill., President and Manager, Illinois Clay Products Company.

Jones, Richard E., 1886 N. Fourth St., Columbus, Ohio, Student, Ohio State University.

Justice, Ithamar M., Dayton, Ohio, Vice-President, Manufacturers Equipment Company.

Kahn, Isaac, 2428 Reading Road, Cincinnati, Ohio, Owner, Wheatley Pottery Company.

Kanengeiser, Fred R., Poland, Ohio.

Kebler, Leonard, Mt. Vernon, N. Y., Ward-Leonard Electric Company.

Keehn, Clarence C., Canandaigua, N. Y., Treasurer and General Manager, Lisk Manufacturing Company, Ltd.

Keeler, R. B., 2505 E. 54th St., Huntington Park, Los Angeles, Cal.

Keenan, John F., 629 Pioneer Bldg., Seattle, Wash., General Manager, Denny-Renton Clay and Coal Company.

Kempf, John R., Detroit, Mich., Star Corundum Wheel Company.

Kendrick, Lucius S., 513 Bearinger Bldg., Saginaw, Mich., Vice-President and General Manager, Central Michigan Clay Products Company.

Kent, G. G., 241 Cavalry Ave., Detroit, Mich., Star Corundum Wheel Company.

Kenyon, S. Spicer, Alfred, N. Y., Student, New York State School of Clay-Working and Ceramics.

***Keplinger, Robert B.,** Canton, Ohio, Assistant General Superintendent, Metropolitan Paving Brick Company.

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Kier, Samuel M., 2243 Oliver Bldg., Pittsburgh, Pa., President, Kier Fire Brick Company.

***Kimble, Herman K.,** Vineland, N. J., Manager, Scientific Glass Department, Kimble Glass Company.

Kimes, A. W., 733 Summerlea St., Pittsburgh, Pa., Publisher, "National Glass Budget."

* Elevated to Active Membership, February, 1920.

Kirk, H. S., New Castle, Pa., Secretary, Universal Sanitary Manufacturing Company.

***Kleymeyer, H. C.,** Furniture Bldg., Evansville, Ind., General Manager, Standard Brick Manufacturing Company.

Kline, Z. C., Central Falls, R. I., National Lamp Works.

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***Knollman, Harry J.,** 116 N. Paxon St., Philadelphia, Pa.

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Koch, A. L., Apartment 25, 20 Prescott St., Cambridge, Mass.

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Koch, Julius J., 3325 Carolina St., St. Louis, Mo.

Koerner, Walter E., Harrison, N. J., Chief Glass Chemist, Edison Lamp Works.

Koos, E. Kenneth, New Cumberland, W. Va., Chelsea China Company.

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Kraus, Louis P. (address unknown).

Kraus, Lysle R., 67 Overpeck Ave., Ridgefield Park, N. J., Research Engineer, Secretary, Kraus Research Laboratories, Inc.

Krause, George, R. F. D. No. 1, Zanesville, Ohio.

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Kreger, John M., Trenton, N. J., Factory Manager, Monument Pottery Company.

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Krusen, I. Andrew, St. Louis, Mo., Laclede-Christy Clay Products Company.

Kurtz, John C., Rochester, N. Y., Bausch & Lomb Optical Company.

Kurtz, Thomas N., Claysburg, Pa., Standard Refractories Company.

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Laird, Charles, Wellsville, Ohio, McLain Fire Brick Company.

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Lambie, J. M., Washington, Pa., Vice-President and Assistant General Manager, Findlay Clay Pot Company.

Lamont, R. A., Jr., Salem, Ohio, General Manager, National Sanitary Company.

Landsheft, C. F., 939½ Market St., Parkersburg, W. Va., Superintendent, The Vitrolite Company.

Lapp, G. W., LeRoy, N. Y., Electrical Engineer, Lapp Insulator Company.

Lardin, R. H., Creighton, Pa., Assistant Chemist, Pittsburgh Plate Glass Company.

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* Elevated to Active Membership, February, 1920.

Larkins, Samuel B., Salineville, Ohio, Superintendent, National China Company.

Larson, Gustaf, 1426 Carroll Ave., Los Angeles, Cal., Los Angeles Pressed Brick Company.

Laughlin, Samuel O., Wheeling, W. Va., President and General Manager, Wheeling Tile Company.

Lawson, Carl H., 3 Fraternal Ave., Worcester, Mass., Norton Company.

Lawson, Geo. G., 2525 Clybourn Ave., Chicago, Ill., Northwestern Terra Cotta Company.

Lawton, Lewis H., Trenton, N. J., Secretary and General Manager, Jonathan Bartley Crucible Company.

***Layman, Frank E.,** Milwaukee, Wis., Cutler-Hammer Company.

Lemley, W. E., Taylor, Wash., Superintendent, Denny-Renton Clay and Coal Company.

Levings, G. v. B., Seneca, Mo., Resident Manager, American Tripoli Company.

Lewis, E. S., 29 South LaSalle St., Chicago, Ill., Secretary-Treasurer, Advance Terra Cotta Company.

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Lindsay, George W., Denver, Colo., Factory Superintendent, Denver Fire Clay Company.

Ling, Shao Chen, Harrison, N. J., International General Electric Company.

Lintz, E. H., Lackawanna, N. Y., Jewett Refrigerator Company.

Lippert, Charles G., Hillsboro Ill., Assistant Factory Superintendent, Schram Glass Company.

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Livingston, H. J., Buffalo, N. Y., National Grinding Wheel Company.

Lloyd, A., Washington, Pa., Superintendent, Hazel Factory No. 2, Hazel-Atlas Glass Company.

Locke, F. M., Victor, N. Y.

Loeffler, R. W., Frankfort, Ind., Superintendent, Ingram-Richardson Manufacturing Company.

Long, George E., Jersey City, N. J., Vice-President, Joseph Dixon Crucible Company.

* Elevated to Active Membership, February, 1920.

Long, Russell N., Columbus, Ohio, U. S. Bureau of Mines.
***Longenecker, H. L.,** Cambridge, Md., Manager, Cambridge Brick Company.
Lord, F. G., Lewiston, Pa., Sales Manager, Pennsylvania Pulverizing Company.
Louthan, Wm. B., East Liverpool, Ohio, Manager, Louthan Manufacturing Company.
Lovatt, John, 1308 Brunswick Bldg., Trenton, N. J., Kiln Builder.
***Lucas, H. J.,** 2525 Clybourn Ave., Chicago, Ill., Vice-President, Northwestern Terra Cotta Company.
Luke, Charles H., New Bethlehem, Pa., Climax Fire Brick Company.
Luter, Clark A., Baltimore, Md., Chemist, Carr-Lowrey Glass Company.
Lyon, J. Boyd, St. Louis, Mo., Laclede-Christy Clay Products Company.
Lyon, P. W., 1332 Frick Bldg., Pittsburgh, Pa., American Sheet and Tin Plate Company.
***Maddock, Henry E.,** Trenton, N. J., John Maddock & Sons.
Maddock, John, Trenton, N. J., John Maddock & Sons.
Maddock, John B., Trenton, N. J., John Maddock & Sons.
Mahoney, W. T., Chattanooga, Tenn., Assistant General Manager, Cahill Iron Works.
Maicas, Oscar R., 1200 Hudson St., Hoboken, N. J.
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***Malm, Arthur T.,** 18 Orne St., Worcester, Mass., Research Laboratories, Norton Company.
***Maltby, Alfred,** Corning, N. Y., Superintendent, Corning Brick, Terra Cotta and Tile Company.
Mandle, I., 1318 Wright Bldg., St. Louis, Mo., Secretary and Treasurer, Mandle Clay Mining Company.
Mandle, Sidney, 1318 Wright Bldg., St. Louis, Mo., Assistant Treasurer, Mandle Clay Mining Company.
Manion, L. W., 1370 Greenfield Ave., S. W., Canton, Ohio, Designer and Builder of Enameling Furnaces.
Manor, John M., East Liverpool, Ohio, Manager, Golding Sons Company.
Marks, Melville, 29 Broadway, New York City, Moore & Munger.
***Martens, Paul,** Chrome, N. J., Metal and Thermit Corporation.
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* Elevated to Active Membership, February, 1920.

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* Elevated to Active Membership, February, 1920.

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* Elevated to Active Membership, February, 1920.

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* Elevated to Active Membership, February, 1920.

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* Elevated to Active Membership, February, 1920.

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* Elevated to Active Membership, February, 1920.

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* Elevated to Active Membership, February, 1920.

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* Elevated to Active Membership, February, 1920.

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* Elevated to Active Membership, February, 1920.

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* Elevated to Active Membership, February, 1920.

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* Elevated to Active Membership, February, 1920.

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* Elevated to Active Membership, February, 1920.

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Foreign Associate Members

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Shanks, Ronald J., Dalmeny, Barrhead, Scotland, Manager, J. and N. Craig, Kilmarnock.

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American Emery Wheel Works, Providence, R. I.
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Beaver Falls Art Tile Company, Beaver Falls, Pa.
Benjamin Electric Manufacturing Co., Chicago, Ill.
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Brick and Clay Record, 610 Federal St., Chicago, Ill.
Buckeye Clay Pot Company, Toledo, Ohio.
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Macbeth-Evans Glass Company, Pittsburgh, Pa.
Maine Feldspar Company, Auburn, Maine.
F. Q. Mason Color and Chemical Company, East Liverpool, Ohio.
Massillon Stone and Fire Brick Company, Massillon, Ohio.
Maxf Grinding Wheel Corporation, Chester, Mass.
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Philadelphia Quartz Company, 121 South Third St., Philadelphia, Pa.
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Pittsburgh High Voltage Insulator Company, Derry, Pa.
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Potters Supply Company, East Liverpool, Ohio.
Reliance Firebrick and Pottery Company, Ltd., Chanch, Barakar, P. O., East Indian Railway, India.
Roessler and Hasslacher Chemical Company, 709-717 Sixth Ave., New York City.

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The Saxon China Company, Sebring, Ohio.
The Sebring Pottery Company, Sebring, Ohio.
Smith-Phillips China Company, East Liverpool, Ohio.
Standard Pottery Company, East Liverpool, Ohio.
Standard Sanitary Manufacturing Company, Bessemer Bldg., Pittsburgh, Pa.
Star Porcelain Company, Trenton, N. J.
Steubenville Pottery Company, Steubenville, Ohio.
Streator Clay Manufacturing Company, Streator, Ill.
The Taylor, Smith and Taylor Company, Chester, W. Va.
R. Thomas & Sons Company, East Liverpool, Ohio.
Trenton Flint and Spar Company, 203 East State St., Trenton, N. J.
United States Glass Company, South Ninth St., Pittsburgh, Pa.
United States Smelting Furnace Company, Belleville, Ill.
Veritas Firing System, Prospect Laboratories, Trenton, N. J.
Vitro Manufacturing Company, Bessemer Bldg., Pittsburgh, Pa.
Vodrey Pottery Company, East Liverpool, Ohio.
Warwick China Company, Wheeling, W. Va.
The West End Pottery Company, East Liverpool, Ohio.
Western Stoneware Company, Monmouth, Ill.